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TABLE OF CONTENTS.

LEADING ARTICLES: Page

Reinforced Concrete Work at the New Railway Terminal Station at Atlanta, Ga. (illustrated) 399

Clean Air 402

Experiments in the Use of Culicide for Mosquito Destruction 403

The Responsibility of Technical Colleges for the Moral Standards of the Engineering Profession; John Berg 405

Field Methods of Triangulation on the Plains Country in Montana (illustrated); C. F. Stewart 407

Difficult Waterproofing of a Concrete Passenger Subway Under Railway Tracks (illustrated) 409

A High-Pressure Gas Distribution System (illustrated) 409

A Centrifugal Cinder Separator for Power-Plant Smoke (illustrated) 411

The Bactericidal Action of Copper 411

A Large Power Driven Pipe Tapping Machine with Special Sleeve and Valve Connection (illustrated) 412

Some Interesting Results of Tests of Eye-Bars for the Quebec Bridge (illustrated); Theodore Cooper 412

A Centrifugal Pump with a Novel Form of Runner (illustrated 414

Movable Wing Rail Frog in an Interlocking Plant (illustrated) 414

The Photographic Reproduction of Blue Prints (illustrated); W. L. Butcher 414

The Collapse of a Masonry Tower on the Western Departmental Block, Parliament Buildings, Ottawa, Ont.; J. A. M. 418

The Work of Well-Drilling Machines on the Pennsylvania R. R. Low Grade Freight Line (illustrated); W. R. Hulbert 419

Wind Bracing in the Brevoort Hotel Building, Chicago, Ill. (illustrated) 420

Mallet Compound Duplex Locomotive for the Guayaquil & Quito Railway (illustrated) 421

English Three-Cylinder Compound Locomotives 421

The Distribution of Loads on Stringers of Highway Bridges Carrying Electric Cars (illustrated); F. P. McKibben 422

EDITORIAL 415

Government Aid for Testing Materials of Construction—The Duty of Colleges in the Moral Training of Engineers—Belt Lines for Diverting Traffic Around Large City Railway Terminals—The Proposition for a Trans-Alaska-Siberian Railway—The Black Sea-Baltic Ship Canal.

Reinforced Concrete for Train-Shed Roofs 415

LETTERS TO THE EDITOR 416

Another Form of Instrument for Trisecting an Angle (illustrated); Emilio Thivolle—Names for Subdivisional Corners of a Section (illustrated); F. Hodgman, H. M. Stout—Concerning the Movement of Vessels in Narrow Channels; E. H. Beckler—Depth of Thread of Mean Stream Velocities (illustrated); C. L. Swain, F. W. Hanna—The Economy of Water Transportation; Wm. L. Sibert—Notes and Queries.

ENGINEERING NEWS OF THE WEEK 423

PERSONALS 424

ENGINEERING SOCIETIES 424

REINFORCED CONCRETE WORK AT THE NEW RAILWAY TERMINAL STATION AT ATLANTA, GA.

Reinforced concrete has been used in an exceptional variety of forms and with great boldness of design in constructing the large new terminal station at Atlanta, Ga. In the station building proper practically the entire structure, except outside walls—that is, all footings, columns, floors and roofs—are constructed of the material. The large train-shed is of steel construction, but it is founded on reinforced concrete piles, and reinforced concrete is used for retaining walls, platforms, platform roofs, viaducts and other subsidiary structures in connection with the train-shed, the station building and the approaches to them. A notable feature of this reinforced concrete work is the extensive use of open framework forms, such as are employed in steel and timber designs; indeed, we recall the use of these forms to no such extent previously in American practice. The designers and builders of the reinforced concrete work were the Baltimore Ferro-Concrete Co., Baltimore, Md.

GENERAL DESCRIPTION OF THE WORK.

The appearance and general arrangement of the new Atlanta Terminal Station are shown by the accompanying view and by the diagram plan Fig. 1. As will be observed, there are three groups of structures—first, a station building proper, containing the usual lobby, waiting room and other accommodations on the main level, with stories above occupied by offices; second, a train-shed at a level below the station main floor, and, third, a midway and concourse connecting the station and the train-shed.

The point to which attention is directed particularly is that the main service floor of the station is one story above the street level, which is also the train-shed track level. For street traffic to reach the main floor level of the station artificial approaches are required. These comprise principally an inclined embankment forming a plaza between the station front and the street parallel thereto; second, a steel roadway viaduct, forming a balcony along the south fronts of the station and train-shed and carrying Mitchell St. over the railway tracks passing by the train-shed; and, third, a reinforced concrete viaduct, forming a balcony along the north front of the station.

So much for the general layout of the terminal. The present article deals solely with the reinforced concrete work comprised in its construction. This is of such variety and so widely scattered that it is necessary to curtail space by grouping similar constructions, without regard to their location in the structure. In order, however, that this classification may not cause confusion, the reinforced concrete work will first be briefly catalogued for each structure.

VIEW OF THE NEW RAILWAY TERMINAL STATION AT ATLANTA, GA.
Built by the Baltimore Ferro-Concrete Co., Baltimore, Md.

The main station building naturally calls for vast consideration. As originally designed, the building was to have brick walls and a steel framework, fireproofed with terra cotta. In the revised plans reinforced concrete was substituted for the steelwork and fireproofing; but the architectural lines were kept as originally designed and the brick walls were retained. Figs. 2 and 3 show the substituted reinforced concrete work; it comprises footings, columns, floors and roofs.

Turning now to the approaches, we have first the plaza and carriage driveway. The tracks of the Southern R. R. going to the freight yard pass along the front of the station in subway. The roof of this subway is formed by the reinforced concrete floors of the pavilions of the station and by the carriage driveway floor between pavilions which are also reinforced concrete. On the west side of the subway are the walls of the station building, and on the east side is built a reinforced concrete retaining wall, which holds back the fill forming the plaza embankment. This wall is shown at A B in Fig 1, and as is there shown turns a right angle and continues as walls B D and B K, retaining the plaza fill from the roadways shown in the accompanying picture. Wall E F G, Fig. 1, shows another portion of the plaza fill retaining wall system.

Of the viaduct approaches, that along the south side of the station is of steel and does not enter into this description. On the other hand, the viaduct which continues the baggage driveway, crossing the plaza along the north side of the station building, is reinforced concrete. It consists of a slag and girder platform, one edge of which rests on the station building wall and the other edge of which is carried by girders and columns, as indicated in the picture herewith and in Fig. 1. At its rear end this driveway opens into the portion of the station known as the midway, which will now be described.

Along the west side of the station building the Central of Georgia Ry. has its main tracks, over which it was necessary to build a bridge giving access from the station to the concourse and the train-shed. This bridge is really a broad platform, supported by the station wall and by columns and having a roof for shelter. The platform, the column supports and the roof are all reinforced concrete, as is indicated by Fig. 2.

The reinforced concrete work of the train-shed comprises pile foundations and footings, and a remarkably bold design of retaining wall, intended to prevent the fill forming the embankment approach to the train-shed from coming against a neighboring building. There was also built in connection with the terminal work, but by the city of Atlanta, a reinforced concrete viaduct carrying Magnolia St. over certain of the railway tracks entering the terminal.

STRUCTURAL DETAILS.

Itemized briefly, the reinforced concrete work comprises: Footings and columns, floors and girders, roofs, retaining walls, viaducts, and reinforced concrete pile molding and driving. A large amount of the work under each of these items presents no special features, and may be passed

with brief mention; but there are under each item certain special designs that merit descriptions in detail, and these are given in the succeeding paragraphs.

COLUMNS AND FOOTINGS.—The interior supports of the station building floors are a combination of interior walls of brickwork and of columns of reinforced concrete. In addition, there are column supports for the midway platform and roof and for the driveway platform, and one or two special piers and footings.

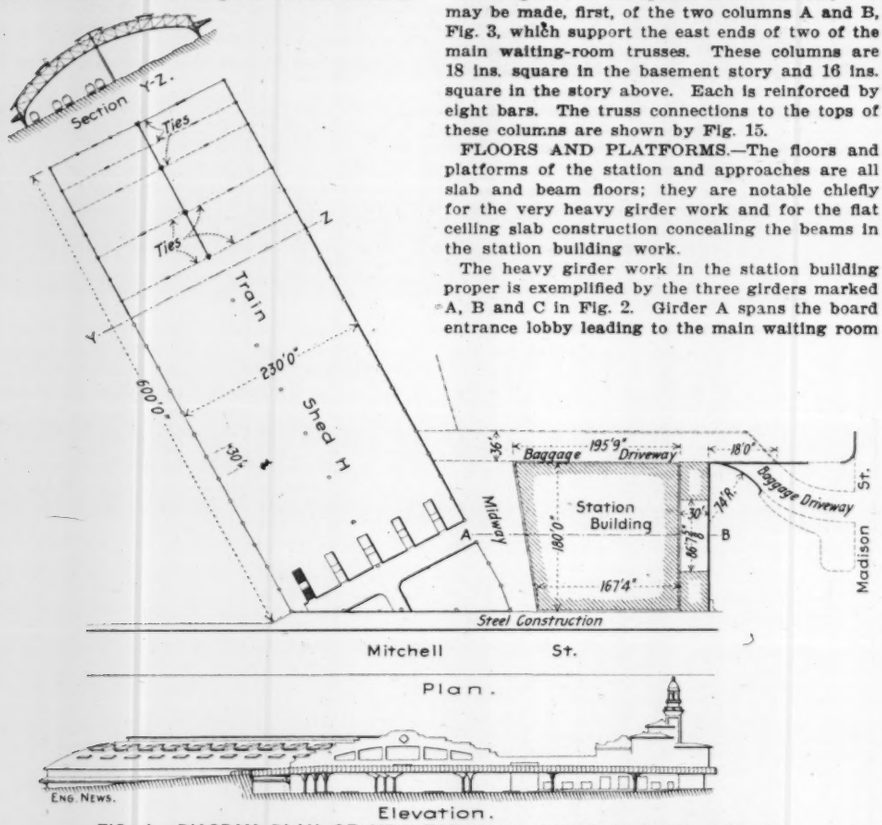

FIG. 1. DIAGRAM PLAN OF NEW TERMINAL STATION AT ATLANTA, GA.

The columns are all square in section and are all founded on square slab footings resting directly on the ground. Those for the station building proper are either 12 ins. or 14 ins. square, depending on the load, with the exception of two which are made longer to serve a special purpose that will be described later. Those carrying the midway platforms are much larger, they being 16 × 16 ins., 20 × 20 ins., 20 × 24 ins. and intermediate sizes; while those under the baggage driveway platform are again 12 ins. and 14 ins. square. All columns up to 16 ins. square, except in one or two special cases, are reinforced by four round steel rods set vertically one in each corner; all larger columns are reinforced by eight rods, one in each corner and one at the middle of each side. These rods are hooped together every 10 ins. by wire ties; their bottoms rest on sheet-steel disks in the footing slab, and their tops connect with the bottoms of the rods in the column above by butt joints enclosed in a sleeve. As a rule, also, the columns decrease in section in each story, and this necessitates, in order to secure the butt joint, bending the lower column rod at the connection, as is shown by the detail Fig. 4.

Typical column footings are shown by Figs. 5 and 6. Fig. 5 shows the footing for columns under the midway platform. This is the largest column and column footing used in the terminal work. As will be seen, the footing is a truncated pyramidal slab reinforced by bars and stirrups. The footings for all the 12 × 12-in. columns for the baggage driveway are similar to that shown by Fig. 5, but the larger columns have the special ribbed footing shown by Fig. 6, or an exactly similar footing, except that the ribs C are omitted. A special footing is shown by Fig. 7. This footing carries a column, or, more correctly, an abutment pillar, set at the angle B formed by the retaining walls A B and B D, Fig. 1. Its construction is clear from the drawings.

Turning now to the special column details, note may be made, first, of the two columns A and B, Fig. 3, which support the east ends of two of the main waiting-room trusses. These columns are 18 ins. square in the basement story and 16 ins. square in the story above. Each is reinforced by eight bars. The truss connections to the tops of these columns are shown by Fig. 15.

FLOORS AND PLATFORMS.—The floors and platforms of the station and approaches are all slab and beam floors; they are notable chiefly for the very heavy girder work and for the flat ceiling slab construction concealing the beams in the station building work.

The heavy girder work in the station building proper is exemplified by the three girders marked A, B and C in Fig. 2. Girder A spans the board entrance lobby leading to the main waiting room and carries two bays of floor, as shown; it is 32¼ ins. deep, 16 ins. wide and 30 ft. 10⅝ ins. clear span. Girder B spans the same entrance way as does girder A, and carries a three-story brick wall as a lintel beam; its span is 28 ft. 11 ins., and its cross-section 16 × 40 ins. The depths given for girders A and B include the 3 ins. depth of the floor slab. Girder C spans the entrance to the passageway leading to the midway; it carries a one-story brick wall on a clear span of 31 ft. 9½ ins., and is 14 × 30 ins. in cross-section. There are a number of other heavy girders in the station building floor, but those itemized are the most noteworthy.

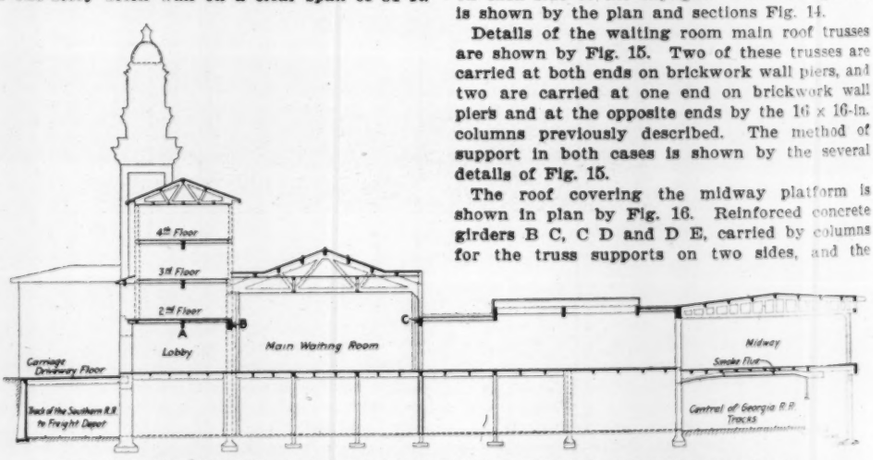

FIG. 2. LONGITUDINAL SECTION OF ATLANTA TERMINAL STATION BUILDING.

Taken as a whole, the heaviest floor work in the terminal is represented by the platform forming the floor of the midway. A plan and sections of this floor are given in Fig. 8. The drawings give all dimensions, so that these need not be repeated. It may be noted that the column shown in Fig. 5 supports column 108, indicating the style of girder reinforcement employed. Details are given of the girders V and Y in Fig. 9. These girders, it should be noted, carry the ends of the baggage driveway beams, as well as the beams of the midway floor. In reference to the sections shown in Fig. 2, it may be stated that, as the locomotives will give off considerable smoke when passing under the platform, it was decided to build smoke flues of concrete suspended under the floor in order to ventilate the space.

The only remaining platform work of much importance is that for the baggage driveway, and this is straightforward slab and girder work. Transverse girders extend from each column to the building wall, and carry lines of girders, the whole being covered with a slab floor, and all parts being reinforced concrete.

ROOF CONSTRUCTION.—Perhaps no item of the terminal work in reinforced concrete shows so many novelties of design as does the roof work. This work comprises the long, narrow roof between main towers, the roofs of the two wings containing the small towers, the roofs of the two pavilions, the roof over the main waiting room and the roof over the midway platform. These roofs are illustrated in Figs. 10 to 17, inclusive.

Fig. 10 shows a plan and two sections of the roof over one of the wings containing the small towers. The main members are the two trusses A and B, which are shown in detail by Fig. 11. The truss form is quite simple, and the details call for no particular mention. Practically the same type of roof is used for the pavilions.

The narrow roof between main towers is shown in plan by Fig. 12. The sections show the roof framing in diagram, and one of the trusses is shown in detail by Fig. 13. The truss form is one very commonly used in steel construction, and the disposition of the reinforcement in tension and compression members at connections and in the corbelled eaves should be noted.

The most important of the several roofs in the station building proper is that over the main waiting room. The clear opening covered by this roof is 116 ft. 4 ins. long and 60 ft. wide. The smaller dimension is spanned by four trusses, spaced as follows, counting from end wall to end wall: 19 ft. 8 ins., 20 ft. 6 ins., 36 ft., 20 ft. 6 ins., and 19 ft. 8 ins. The 36-ft. space between the middle pair of trusses is bisected by an open web transverse girder, which takes intermediate support in two similar girders resting on the trusses and running longitudinally of the roof area, one on each side of the skylight. This arrangement is shown by the plan and sections Fig. 14.

Details of the waiting room main roof trusses are shown by Fig. 15. Two of these trusses are carried at both ends on brickwork wall piers, and two are carried at one end on brickwork wall piers and at the opposite ends by the 16 × 16-in. columns previously described. The method of support in both cases is shown by the several details of Fig. 15.

The roof covering the midway platform is shown in plan by Fig. 16. Reinforced concrete girders B C, C D and D E, carried by columns for the truss supports on two sides, and the supports on the opposite sides are the brick building walls A B and A E. Girder D E is continuous over columns from E to D, and is about 200 ft. long. It is of open web construction, similar to that of the truss X Y shown in Fig. 17. Girder B C is constructed like girder D E, but girder C D is a solid beam. The arrangement of the roof trusses is clearly shown by Fig. 16; they

are all of similar construction, and this construction is clearly shown by Fig. 17, illustrating girder X.

PARTITION WALLS.—The only walls of reinforced concrete in the terminal work are the wall between the track space under the midway and the train-shed and the wall between the midway

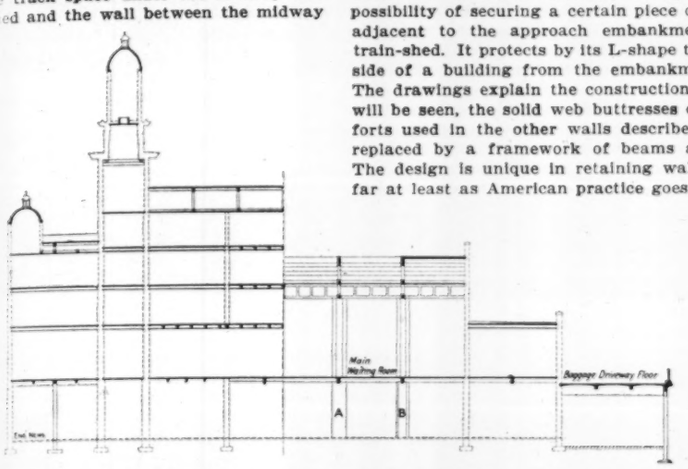

FIG. 3. TRANSVERSE SECTIONS OF ATLANTA TERMINAL STATION BUILDING.

and the concourse. The basement wall is a plain curtain wall or slab of concrete between columns, but the wall above is a rather notable example of girder and post work, designed to carry a large area of window openings. The locations of these two walls are shown in Fig. 2.

RETAINING WALLS. — The retaining wall work comprises the several walls inclosing the fill forming the plaza and indicated in Fig. 1 and the front-page picture, and also an L-shaped wall protecting the end and one side of an adjacent building from the fill forming the embankment approach to the train-shed.

Considering first the plaza walls, it will be seen that the tunnel for the Southern R. R. freight tracks, Fig. 2, is formed by the front wall of the station building on one side and on the other side by a retaining wall which holds back the plaza fill. This retaining wall is indicated at A B, Fig. 1; it is 194 ft. long and 22 ft. 6½ ins. high. Sections of the wall at two points are shown by Fig. 18; these sections show the essential features of construction excepting the spacing of the counterforts which varies from 4 ft. to 6 ft.

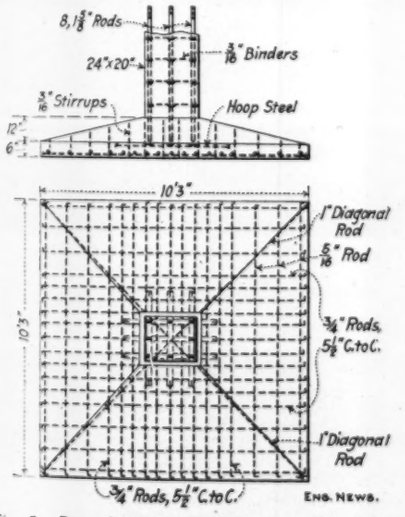

Fig. 5. Pyramidal Slab Footing for 20 x 24-in. Column Supporting Midway Platform.

As will be seen from Fig. 1, the retaining wall just described turns at right angles and continues as a retaining wall supporting the plaza fill on the baggage driveway side. At the turning there is an abutment pillar, details of which are shown by Fig. 7. A plan and elevation of the wall are given in Fig. 19, and Fig. 20 shows special details of various parts as indicated. The other walls of the plaza are comparatively simple.

The wall of the most peculiar construction is that shown by the drawings of Figs. 21 and 22. This wall was made necessary owing to the impossibility of securing a certain piece of property adjacent to the approach embankment to the train-shed. It protects by its L-shape the end and side of a building from the embankment filling. The drawings explain the construction fully. As will be seen, the solid web buttresses or counterforts used in the other walls described are here replaced by a framework of beams and struts. The design is unique in retaining wall work, so far at least as American practice goes.

REINFORCED CONCRETE PILES.—Referring to Fig. 21, it will be observed that piles were driven to support the toe of the L-shaped retaining wall that holds back the train-shed approach embankment. In addition, the rear end of the train-shed way is carried on pile foundations as indicated by the diagram plan, Fig. 1. The general form of pile used is shown by Fig. 23. It should be noted that the train-shed is entirely built on a fill which at certain places reaches 50 ft. in height. In order to have good foundations it would have been necessary to excavate down to the natural ground. This expense was entirely avoided by driving concrete piles. These piles were 12 x 12 ins. square, with a reinforcement composed of four rods tied up with binders. They were concreted horizontally on the ground, the steel framing being made in advance. The concrete piles were allowed to set for about 15 days, then lifted and driven with an ordinary pile driver mounted with a 3,500-lb. hammer dropping about 9 ft. The top of the pile was protected with a cast-iron cap and sawdust was interposed between the concrete and the metal. The concrete on top of the pile is always removed and the bars left bare. Later on the piles were connected by concrete beams on the top longitudinally. Each pile is capable of carrying 50 tons. The survey of the ground had been made before the fill had covered it, and therefore it was possible to foresee the length of the piles on each point where it had to be driven. The train-shed is composed of steel arch supported in its center part by a column. This disposition avoids almost entirely the thrust on the abutments. However, it was decided to tie up the top of the foundation piles transversally, and this was done by means of reinforced concrete tie beams arranged as shown by Fig. 1.

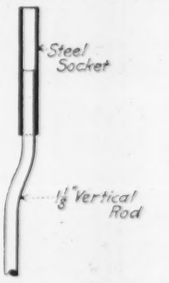

Fig. 4. Column Reinforcing Bar Connection at Floor Level

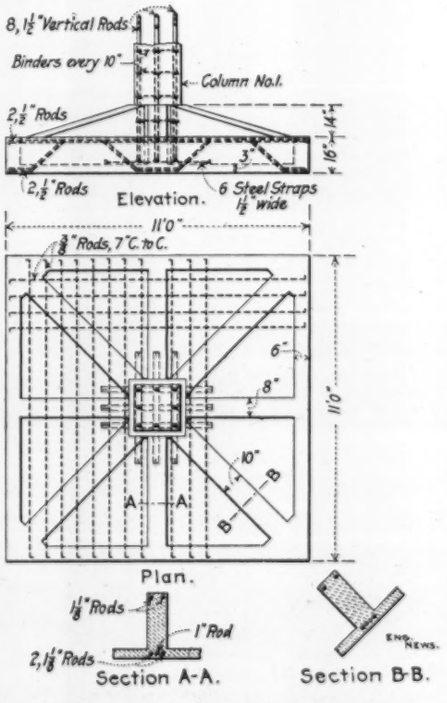

Fig. 6. Ribbed Slab Footing for 20-in. Square Column Supporting Baggage Driveway.

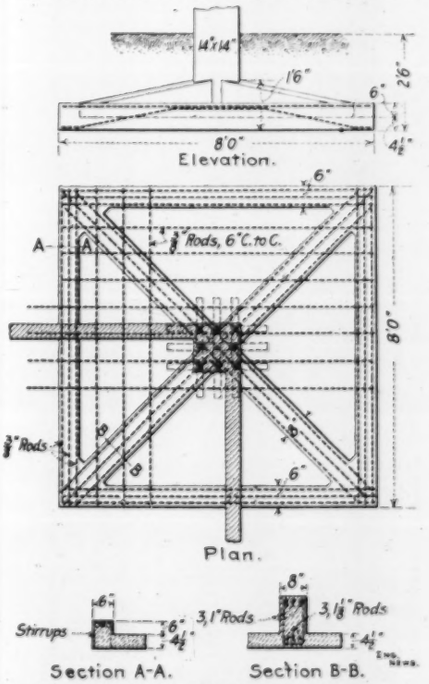

Fig. 7. Ribbed Slab Footing for 14-in. Square Pillar at Junction of Two Retaining Walls.

A GOLD DREDGE, built by the Atlantic Equipment Co., of New York City, from designs by Mr. A. W. Robinson, M. Am. Soc. C. E., is now in successful operation at Ransom's Bridge, N. C., on property of the Gold Bond Dredging Co. The dredge is of the endless bucket type, the buckets being close-connected to the chain on a system devised by Mr. Robinson, so that double the number of buckets work in a given time for a certain speed of the chain as compared with the ordinary open-connected bucket. The buckets are of 6 cu. ft. capacity and at normal speed 24 per minute empty into the hopper. The hopper discharges into a circular revolving screen 4 ft. 6 ins. diameter and 16 ft. long. From the end of the screen an endless rubber-belt delivers the coarse tailings at a point 70 ft. away and 25 ft. above the water level. The material passing through the screen runs over gold saving tables covered with riffles, having a total area of 336 sq. ft. and in addition there are 94 sq. ft. of riffles in the distribution and tailings sluices.

The hull of the dredge is of wood, 94 ft. x 32 ft. x 7 ft. The ladder frame is long enough to dredge in 30 ft. of water. The bucket-pins are of steel, running in manganese steel bushings so arranged as to be readily renewable. The main engine is of 50 HP. and an independent 10-in. centrifugal pump with direct-connected engine furnishes water to the screen and tables. In 30-days' trial working of this dredge the remarkable run of 76% actual working time was made. The delays, amounting to 24% of the time, included all the time spent in adjusting the new machinery and correcting small defects.

CLEAN AIR.

One of the earliest physicians to give intelligent attention to the relations between bacteria and general sanitation was Dr. T. Mitchell Prudden, of New York. At a meeting of the Practitioners' Society in New York City on Jan. 5, 1906, Dr. Prudden read a long paper on "Clean Air," from which we extract some of its many interesting features. By "clean air" he referred not to air renewed by ventilating processes, but to air free from floating dust, and particularly air loaded or liable to be loaded with the specific germs of disease.

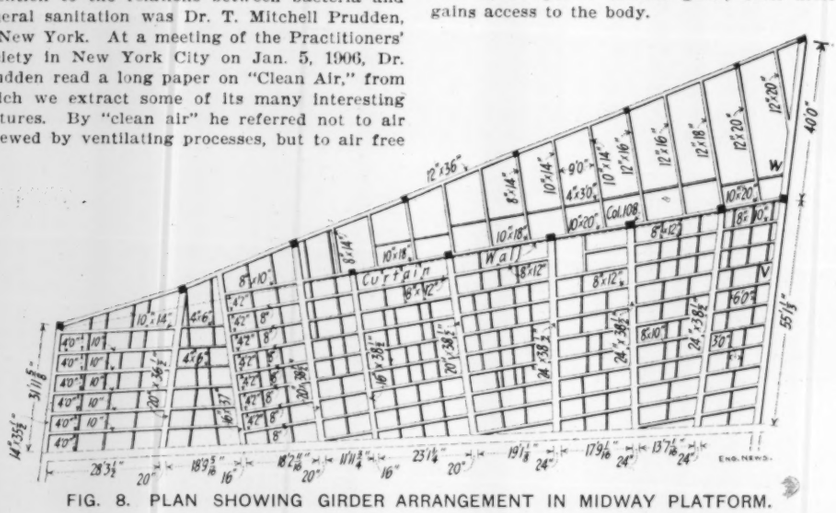

FIG. 8. PLAN SHOWING GIRDER ARRANGEMENT IN MIDWAY PLATFORM.

In studying this question it is important to know the physicial conditions governing the dissemination of fine particles through air, how long such particles can remain in suspension, and how the suspension of infectious micro-organisms in the air affect their viability and virulence. Bacteria are not [contrary to common belief] "readily separated from fluids or moist surfaces by air currents," and [more surprising still to some] "the exhaled breath is practically germ-free, even in those suffering from communicable infectious diseases." As will be shown later in this abstract, however, this is not true of the spray that is violently projected from consumptives and other diseased persons when they cough or sneeze. Harmful microbes have many natural enemies, such as sunlight, dessication and sometimes immersion in water, being either killed or at least greatly reduced in virulence by such means. Fortunately for man, his living tissues have a remarkable capacity for killing and safely disposing of most of the bacteria which gain access thereto. The latter is so largely true that most surgeons of the present day have no fear of ordinary air as a means of infecting wounds in an operating room, and therefore "concentrate their attention upon direct sources of infection, such as hands, instruments, dressings, the seat of operation, etc." Surgery aside, predisposition of the host is the most important factor in infection by a specific disease germ, even after it gains access to the body.

Notwithstanding the facts just cited, it is of importance to secure clean air, and, therefore, to know how to determine the extent of its dust burden. What Dr. Prudden described as the "most accurate and ingenious method of dust analysis" was devised by an Englishman, and is named after him—the Aitken Dust Counter. This was described by Dr. Prudden as follows:

> The "dust counter" as it was finally perfected consists of a small, accurately measured, air-tight chamber, connected with an air pump and with an arrangement for introducing small measured volumes of dusty air. The air chamber, saturated with moisture, is first charged with a measured amount of the air. Then with a sharp thrust of the air pump a partial vacuum is created in the chamber. The air expands, and as it does so suddenly cools, so that a fog droplet is formed around each floating dust particle. The operator is watching the illuminated interior of the chamber through a lens and can see the shining droplets as they suddenly flash into the field of vision and fall in a minute shower upon a ruled plate at the bottom of the chamber. Then, when all the fog droplets have fallen and the mimic shower is over, he counts the microscopic splashes, each one representing a whilom floating dust particle, and makes his simple calculation of the number which were in a thimbleful, or a breath, or a roomful of the dusty air. No matter how small the floating particles may be, the fog catches them every one.

With this instrument Professor Aitken found that "the devotee to the gentle cigarette may set free upon an unwilling environment at one full average exhalation not less than four thousand million particles of smoke." Even impure air, however, contains a much less number of dust particles than this, but "dry winds may keep dust particles upward in vast numbers for the ground and hold them suspended for hours upon the air driven hither and thither in clouds of varying density."

The bacterial contents of air are determined most commonly by filtering a known volume of air through dry sterilized sand and subsequently making bacterial cultures therefrom, or by exposing culture plates to the air for definite periods. In either case, of course, bacterial counts are made of the number of colonies that develop on the culture plate. Bacterial analyses of air in dwellings and public assemblies have shown the tubercle bacillus, pneumococcus, diphtheria, anthrax, tetanus and other disease germs. But Dr. Prudden states, many of the organisms so found

> have been gathered under conditions which did not indicate that they were in such a finely divided state that they could have contributed largely to the risks of dust infection through inspired air.

Studies by Stern and others have shown that neither ordinary ventilation nor even the opening of windows when the wind is blowing will effect the removal of dust from rooms. Neither will the mere hanging of garments or carpets out of doors result in freeing them from infective agents unless the articles are brushed, beaten or otherwise subjected to violent movement.

One of the most significant means of disseminating infective material through the air is the sneezing, coughing and also the ordinary speech of persons suffering with troubles which result in secretions of the nose, mouth, throat or lungs. The direct infectious zone thus produced does not usually extend beyond 2 or 3 ft., but

> so minute are the particles often expelled in enormous numbers in the commonly invisible spray of sneezing, that these may be carried for many feet on air currents as slow as those involved in ordinary ventilation or such as are invariably present in inhabited rooms.

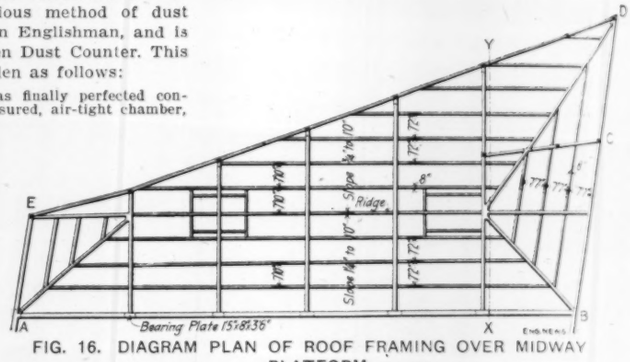

FIG. 16. DIAGRAM PLAN OF ROOF FRAMING OVER MIDWAY PLATFORM.

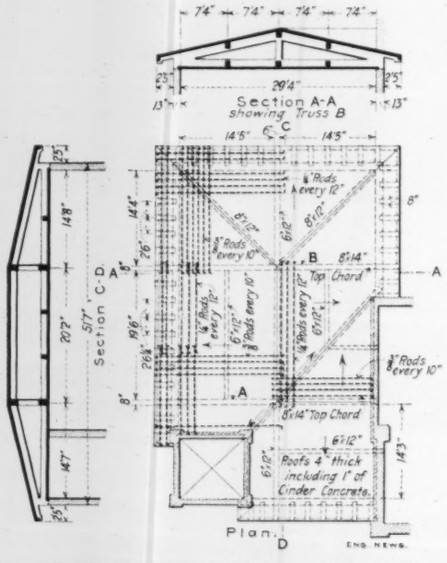

Fig. 10. Plan and General Sections of Roofs Over Wings Containing Small Towers.

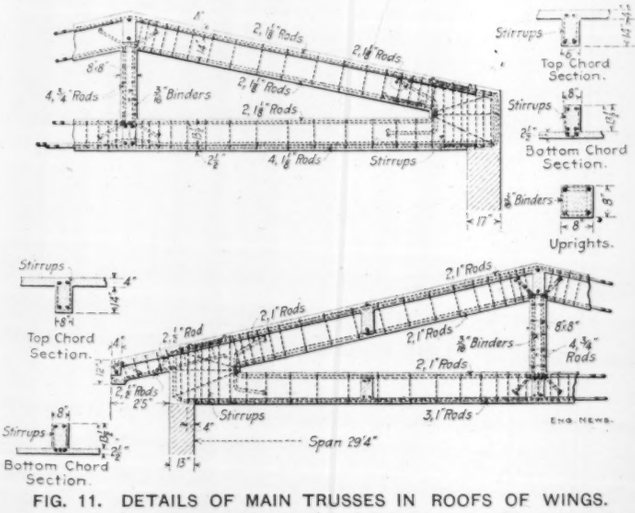

FIG. 11. DETAILS OF MAIN TRUSSES IN ROOFS OF WINGS.

Walking over floors on which bacteria-laden dust has settled stirs up large numbers of germs, but as a rule these rise only a few feet and then slowly fall back again. Clouds of germs, however, may be sent into every part of a room by the dry sweeping of floors.

Nature guards man against the evil effects of dust in the air, but cannot positively insure him against all dangers. In normal breathing through the nose, a part of the dust and bacteria of the inhaled air is retained upon the moist surfaces of the air passages, and subsequently cast out, or in the case of micro-organisms, which penetrate deeply, the latter are destroyed by the phagocytes. Where excessive amounts of dust are continuously inhaled the lungs may become clogged and thus made more readily liable to infection by such micro-organisms as gain access to them.

The chief communicable diseases subject to

...transmission are "influenza, whooping-cough, pulmonary tuberculosis, diphtheria, cerebro-spinal meningitis and the various forms of septic infectious pneumonia." The greatest dangers from these sources are obviously in...where dust-charged air is liable to contamination from infectious wastes thrown off by diseased persons in spitting, sneezing and coughing. Protection against aerial infection through...dust consists, obviously, (1) in limiting the amount of infectious material by the control, so far as possible, of spitting and unguarded coughing and sneezing, and (2) in employing such methods of cleaning as shall remove the dust from rooms without spreading it through the air. All measures designed to prevent promiscuous spitting in public places aid in the first way. Where sweeping must be practiced it is very desirable that it should be done at times when the rooms are unoccupied and can remain so until the dust has a sufficient opportunity to settle. In so far as subsequent "dusting" is performed, it should be done by means of damp cloths rather than by dusters, which merely disseminate the dust through the air once more. In private houses, and, in fact, in all carpeted rooms, a large portion of the dust may be gathered and held by covering the carpets with moistened shreds of paper. The vacuum process of cleaning "affords a valuable means of getting safely rid of a considerable amount of dust," but thus far plants for its use are not general. Filthy and dangerous dust may be expected wherever places of public assembly are carpeted.

While some people are very particular about the cleanliness of clothing, food and drink, they have no regard whatever for bearing away

upon the delicate membranes of [their] respiratory organs from places of public concourse the pulverized excretions of the filthy and diseased. . . . In a considerable proportion of cases in theaters and court-rooms, in offices and public conveyances, in factories and stores, the floating dust of to-day is pregnant with the spit of yesterday.

Formerly street sweepers in New York were required to sprinkle in advance of their brooms, but recently

we are forced to lend to the street-cleaning department the good offices of our respiratory mucous membranes, already overtaxed by the requirements of the theater man, the storekeeper, and the trolley car folks, by the traditions of domestic service, and by the house committees of our clubs.

If, in New York, the beneficent law against the smoke pollution of the air were in force; if the streets were properly cleaned; if the great passenger transport systems were placed under competent sanitary supervision; if the Health Department were persistently alert in enforcing the ordinance of the Sanitary Code which relates to spitting in public places; and if we could get sweeping and dusting in-doors intelligently done, we should have in this city, in my opinion, a fair outlook towards a great advance in the reduction of diseases of the respiratory organs. . . . . The infectious diseases of the respiratory organs are steadily increasing as people are more and more huddled together in offices, dwellings, traveling conveyances and places of public assemblies.

Promiscuous spitting can and should be stopped. Coughing and sneezing cannot be prevented, but in most instances their harmfulness can be controlled by the use of the handkerchief, or, in case of need, by such use of the hand as shall answer the dictates of primitive decency. . . . . As regards public conveyances and places of public assemblage, I see no reason why health authorities should not as properly prescribe regulations for cleaning and the removal of dust, and compel their practice, as they compel the sanitary disposal of sewage, secure pure drinking water, and condemn noxious articles of food.

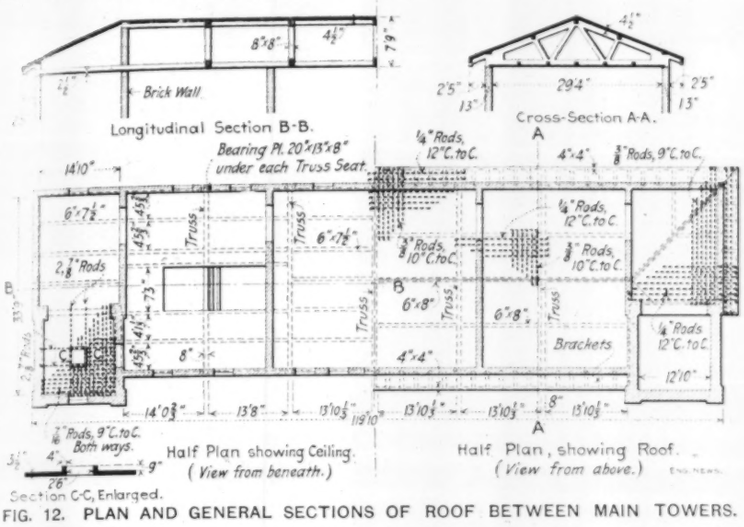

FIG. 12. PLAN AND GENERAL SECTIONS OF ROOF BETWEEN MAIN TOWERS.

EXPERIMENTS IN THE USE OF CULICIDE FOR MOSQUITO DESTRUCTION.

Since the acceptance of the mosquito as the agent in the spread of malaria and yellow fever the necessity for some means of mosquito destruction within houses in mosquito-infected districts has become apparent. The two methods most commonly used for this purpose have been the burning of sulphur and pyrethum. A new agent has recently been tried with apparent promise of great future usefulness. A detailed report on this subject by Passed Assistant Surgeon Berry, now located at Tampa Bay Quarantine, was published in "Public Health Reports" of the U. S. Marine Hospital Service for Feb. 2, 1906.

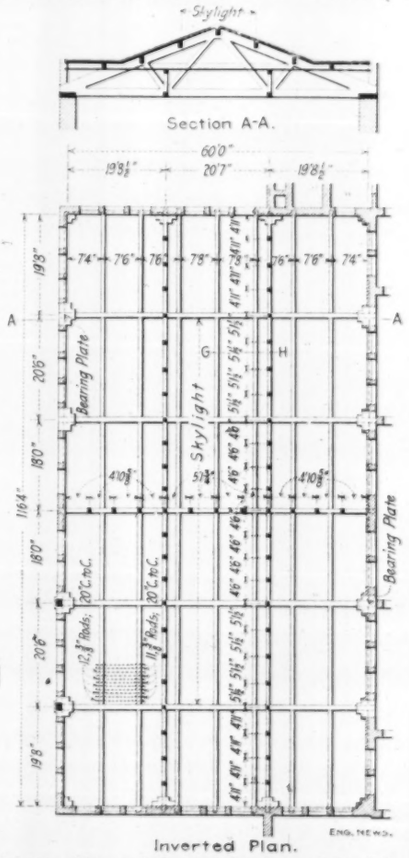

Fig. 14. Plan and General Sections of Roof Over Waiting Room.

The agent involved has been named "Mims Culicide," from Professor Mims, of New Orleans, who first suggested its use. It is a vapor produced by heating a mixture of carbolic acid and camphor. After several experiments by others and later by Surgeon Berry himself, it was found that an effective way of generating the vapor was to place the mixture in an evaporating pan, above an alcohol lamp, the lamp being surrounded by a piece of ordinary stove-pipe 6 ins. in diameter and 8 ins. high. Pieces should be cut out of the lower portion of the stove-pipe, leaving only legs for it to stand upon, and thus admitting air, and the pipe should also be perforated with half a dozen ¼-in. holes, placed about ½-in. from the top. Without these openings below, the mixture to be vaporized is liable to take fire from the heat generated, and without the perforations the lamp burns irregularly. The lamp should be placed in a tin pan or other receptacle containing ½-in. or so of water, thus keeping the bottom portions of the lamp cool and safeguarding against any danger from leaks of alcohol from the lamp. After several experiments it was found that for an evaporating pan an ordinary granite wash-basin was most satisfactory. The size of the basin was such that the outside rim at the bottom just fitted the stove-pipe. With other pans the evaporation was not complete, but with this one every drop of the culicide was used.

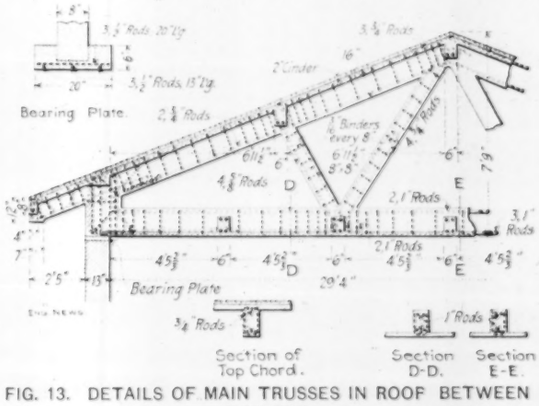

FIG. 13. DETAILS OF MAIN TRUSSES IN ROOF BETWEEN TOWERS.

When first beginning the use of this agent Surgeon Berry was supplied with a 4½-gallon carboy of material obtained by mixing 20 lbs. each of camphor and carbolic acid crystals. The acid at practically wholesale prices cost 22 cts. per lb. and the camphor 80 cts. per lb., making a total of $20.40 for material. The cost of labor brought the total cost up to about $22, or at the rate of less than 4 cts. per oz. The cost of camphor at the time was very high, due, it is said, to its extensive use during the recent Russo-Japanese war. A reduction to 40 cts. per lb., which Surgeon Berry seems to think a sufficient price, would reduce the cost of the mixture to 2 cts. per oz. As it was, the cost of the carboy of culicide was less than that of a 100-lb. barrel of pyrethrum, then quoted at 25 cts. per lb. Surgeon Berry adds that it is believed a large part of the pyrethrum on the American market is heavily adulterated with camel's dung.

The carboy of culicide described above was used under the direction of Surgeon Berry in one of the wards of New Orleans during the recent outbreak of yellow fever in that city. It was found that a sufficient amount of culicide could be evaporated in a room in 20 minutes, and that at the end of that time the room could be entered, the apparatus removed and the mosquitos and other insects swept up and destroyed. It was found that the work could be expedited by darkening all windows except one and placing a sheet beneath that one, thus concentrating the majority of the mosquitos upon the sheet. It is necessary to burn pyrethrum two hours to bring down all the mosquitos. Sulphur acts as quickly on the mosquitos as culicide, but it is a long time after it is burned out before the room can be entered with comfort, if at all, to remove the apparatus, and a much longer time before the room can be

used. In addition, as is well known, sulphur damages many fabrics and furnishings.

Besides the practical work done by Surgeon Berry at New Orleans, the culicide was used satisfactorily in another part of the city by Surgeon Blue, and after that some experiments were conducted at the Marine Hospital at New Orleans. The details of these seven experiments are given in the report mentioned at the beginning of this article. The experiments were conducted by Passed Assistant Surgeon Goldberger, who arrived at the following conclusions, in which Surgeon Berry concurs:

(1) Culicide in the proportion of 4 ozs. per 1,000 cu. ft. used for 2 hours with apparatus similar to that used by us kills *Culex pungens*, *Stegomyia*, and *Anopheles maculipennis* and temporarily stuns the house fly.

(2) In the proportion of 3 ozs. to 1,000 cu. ft. it does not always kill the *Anopheles maculipennis*.

(3) Culicide takes fire spontaneously if heated sufficiently. It is therefore necessary to keep the liquid at a certain distance from the flame; it is also better to have more than one basin in a large space, and about 8 ozs. is the maximum quantity to use in one pan. All large cracks must be pasted up—the doors and windows if loose fitting. Gummed paper spread under a window left light would be of great benefit. (I concur with Passed Assistant Surgeon Goldberger as to the closing up of large cracks, but more for preventing weakening of the strength of the gas in the room by diffusion than from any belief that insects might escape from the room.)

(4) In the hands of intelligent operators, and used according to the methods employed by us, it ranks next to sulphur as an insecticide in practical fumigation.

(5) Culicide vaporizes and later cools, condensing on exposed surfaces again as it cools. Whether in this way it injures articles of gilt and the like was not investigated. In practical work the only articles removed from rooms were food stuffs and animal pets and no complaint of injury was received. It gradually evaporates, leaving a persistent, though not disagreeable, odor.

Surgeon Berry states that the cost of fumigating with culicide at the present high prices for the materials composing it, and using 4 ozs. of the agent per 1,000 cu. ft. of room, is 16 cts. per 1,000 cu. ft., as compared with 7 cts. for sulphur and 50 cts. for pyrethrum, using 2 lbs. of both the latter per 1,000 cu. ft. These figures do not include the cost of alcohol for evaporating the culicide, but it is stated that this is not much, if any, more than the cost of alcohol to ignite pyrethrum or sulphur pots. Moreover, the culicide is used in such small quantities that it can be conveyed in street cars or by hand from place to place, whereas with sulphur a wagon would be required to transport the materials and apparatus, and in addition to this many articles would have to be removed from the house being disinfected, and much more pasting would be required to make the rooms airtight.

The effect of culicide upon insects is to intoxicate them so that they buzz around the room aimlessly and fall suddenly, whereas when sulphur is used the insects can make more intelligent efforts to escape. Flies in particular are intoxicated by the culicide. Cockroaches are able to attempt to escape through cracks, but Surgeon Berry says he has killed them by using 3 ... culicide per 1,000 cu. ft. of room space ... effect of the culicide upon man is smaller ... would be expected, considering its compo... Surgeon Berry says that only once did he e... ence ill effects while using it, and that was ... being "all day long in and out of rooms" where culicide was being used for fumigation. He then "experienced a feeling of nausea, with free flow of saliva, lasting half an hour." The vapors, after being breathed for a short time, cause "a feeling of numbness about the lips and pharynx."

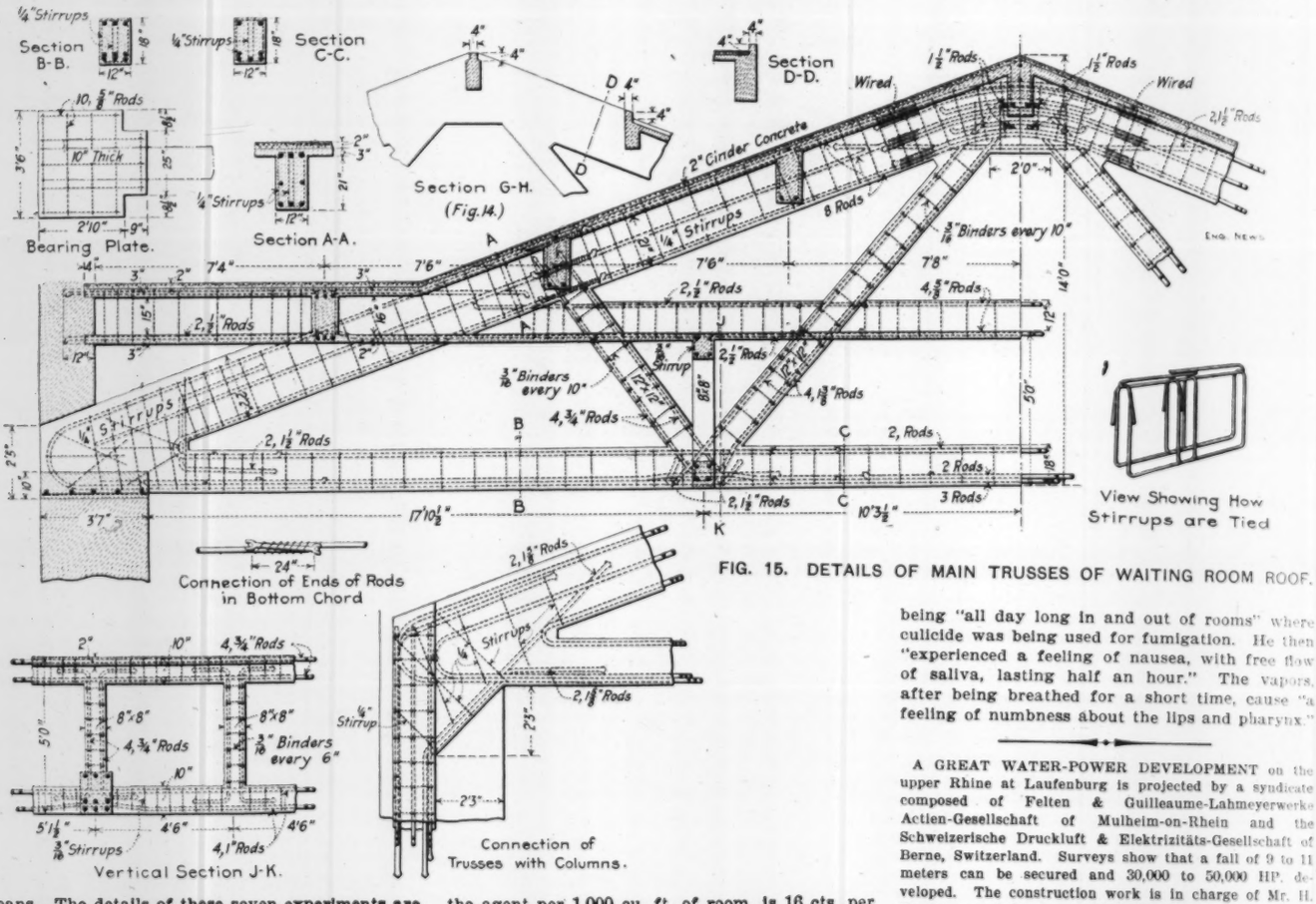

FIG. 15. DETAILS OF MAIN TRUSSES OF WAITING ROOM ROOF.

A GREAT WATER-POWER DEVELOPMENT on the upper Rhine at Laufenburg is projected by a syndicate composed of Felten & Guilleaume-Lahmeyerwerke Actien-Gesellschaft of Mulheim-on-Rhein and the Schweizerische Druckluft & Elektrizitäts-Gesellschaft of Berne, Switzerland. Surveys show that a fall of 9 to 11 meters can be secured and 30,000 to 50,000 HP. developed. The construction work is in charge of Mr. H. E. Gruner, of Basel, as resident hydraulic engineer.

CONTINUOUS-RECORD ELECTRIC INSTRUMENTS have just been brought out by the Westinghouse Electric & Mfg. Co., of Pittsburg, Pa. The record is made on a continuous strip of paper about 6 ins. wide by a fountain pen having a straight-line motion across the strip. The pen is moved by a pair of solenoids, energized from a separate source of current, which are controlled by contacts on the moving coil or meter element. The sensitiveness of the pen may be regulated, so that the record may be made to follow every variation in the quantity measured, or may be made to slur the small irregularities and form a smooth curve. The paper is driven by a self-winding clock and may be run at various speeds between 2 ins. per hour and 8 ins. per hour, by changing gears in the clock drive. This type of instrument is made as am-

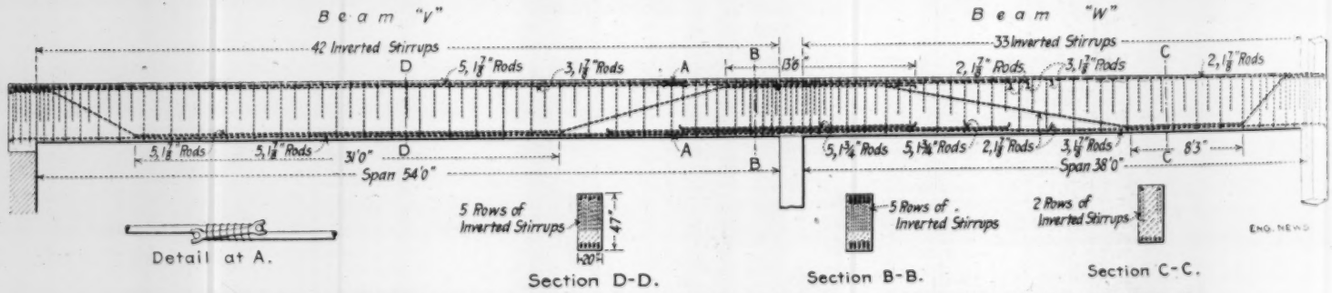

FIG. 9. DETAIL OF GIRDER CARRYING BAGGAGE DRIVEWAY AND MIDWAY PLATFORMS (GIRDER W-V, FIG. 8).

meter, voltmeter, and wattmeter, for direct current and for alternating (single-phase and polyphase) current, and frequency and power-factor meters for alternating current. The instruments are not affected by vibration or by external fields. They measure about 13 x 16 x 9 ins. (over the glass case) and are intended to be mounted on a wall or a switchboard.

THE RESPONSIBILITY OF TECHNICAL COLLEGES FOR THE MORAL STANDARDS OF THE ENGINEERING PROFESSION.

By John Berg.*

The increasing complexity of technical problems presents unusual opportunities to men of extraordinary mental capacity. Add executive ability and initiative to the above qualification, and you have an engineer who can name his own price for his services. Different it is with the ordinary undergraduate, though he may be pretty well on in his course. When his physical equal and mental inferior gets four and five dollars a day working at a trade, during the learning of which he earned no mean wages, the engineering student is advised to accept a tender of ten dollars a week or less, if such an offer comes his way.

Wages is a true indicator of the ratio of demand to supply. Who gets a "corner" on technical help? "The woods are full of 'em." For the benefit of those already in the profession, as well as those just crossing its threshold, a temporary relief for the situation would be effected by increasing the quality of output of the engineering schools at the expense of quantity. This might be done (1) by increasing the length of the course; (2) by increasing the amount of the work done in the course; (3) by making more rigid entrance requirements; or (4) by raising the standard of scholarship in the present course.

To take more time than formerly is not consistent with the hurrying spirit of the age. Hence the first proposition is not feasible. To increase the number of courses or the amount in the existing courses in an effort to raise the average mental capacity of the thorough student would be at the expense of physical development and consequent loss in mental capacity. To make the entrance requirements more rigid would result in the exclusion of promising raw material from rural communities and other places where preparatory schools are poor.

The survival of the fittest is law in every other vocation of life, and this may as well be recognized in college as elsewhere. An application of the fourth proposition, then, seems most feasible. Let the standard of scholarship be raised; more thoroughness in the student's work be required; capability and absolute honesty at no premium; but underhanded work, whether it be "copying," "cutting," "flagging," "faking," "cribbing"—in fact, let any dishonest work be at an effective discount.

"There's the rub." This differentiation of the worthy from the unworthy places technical colleges—the individual teacher, the honor-loving student himself, if you please—in a position of great responsibility. Presently "it is within bounds to say that the reputation of the engineering profession will hang on the work done at Panama," but finally it will be equally pertinent to say that the reputation of the engineering profession will hang on the work done in the engineering schools of the immediate future.

The engineering student of the present who beats his way through college till commencement day may become the irresponsible engineer or contractor who defrauds his client, lowers the wages of honest talent, brings disrepute to his alma mater, and invites calumnies upon his professional brethren.

The question now naturally arises, Whence the information to which to apply the standard of the college? Though the proposition is a difficult one, it is not in every respect wholly impossible. Teachers and students have better opportunities of knowing each other in engineering schools than in other colleges. The teacher should not give high credit for poor work, for two reasons—it is almost as unfortunate to encourage a student to continue for years the preparation for a profession beyond his natural ability as it is dishonorable to recommend a student for advancement who is proving beyond a doubt that he will not be true to the ethics of his profession.

The young man old enough to be a college student who reports three hours' work in the field when a credit of one and one-half hours would be giving overtime is going to report a full day's work to his chief when he may have been laying off most of the day, and, perhaps, what is still worse, manufacturing field notes. The members of a student party found playing tennis when they should have been doing their field exercise with the level are not the men upon whom can be safely placed the responsibility of determining the different elevations for expensive bridge piers.

Success and good reputation in the various fields of the profession depends not altogether on ability, but no less on an even-tempered disposition. The student who becomes almost frantic with rage when one of the new instruments in the laboratory is not assigned to him will some

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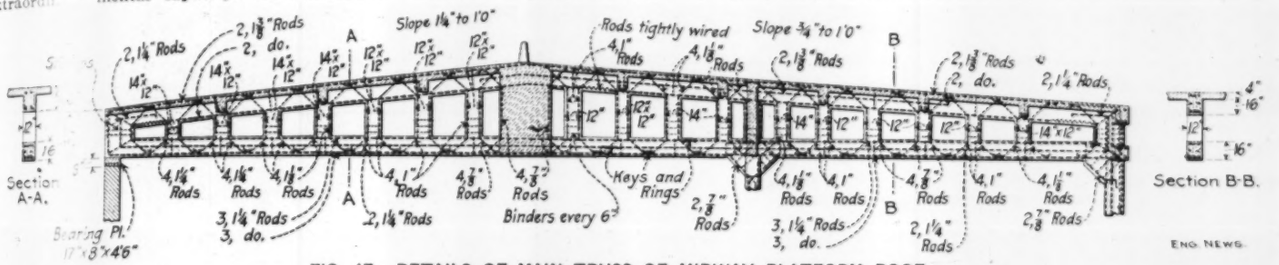


FIG. 17. DETAILS OF MAIN TRUSS OF MIDWAY PLATFORM ROOF.

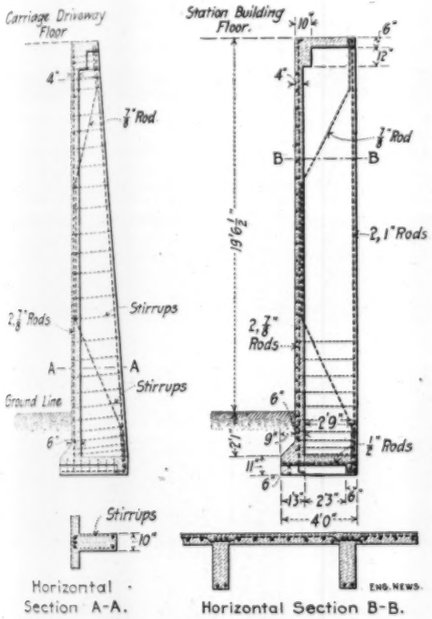


Fig. 18. Sections of Retaining Wall Holding Back Plaza Fill From Southern Railway Freight Tracks.

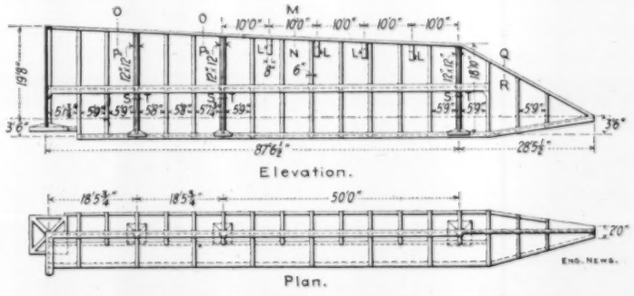


FIG. 19. PLAN AND ELEVATION OF MAIN RETAINING WALL OF PLAZA.

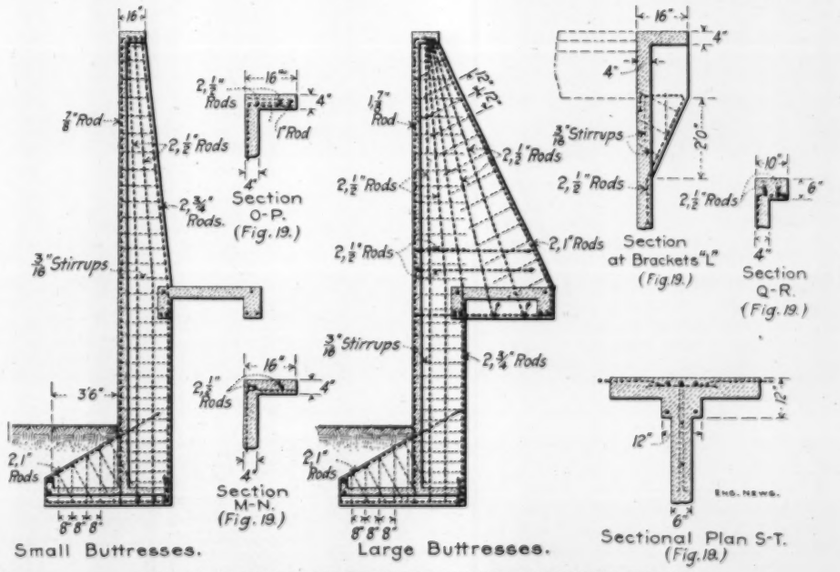


FIG. 20. DETAILS OF RETAINING WALL SHOWN IN FIG. 19.

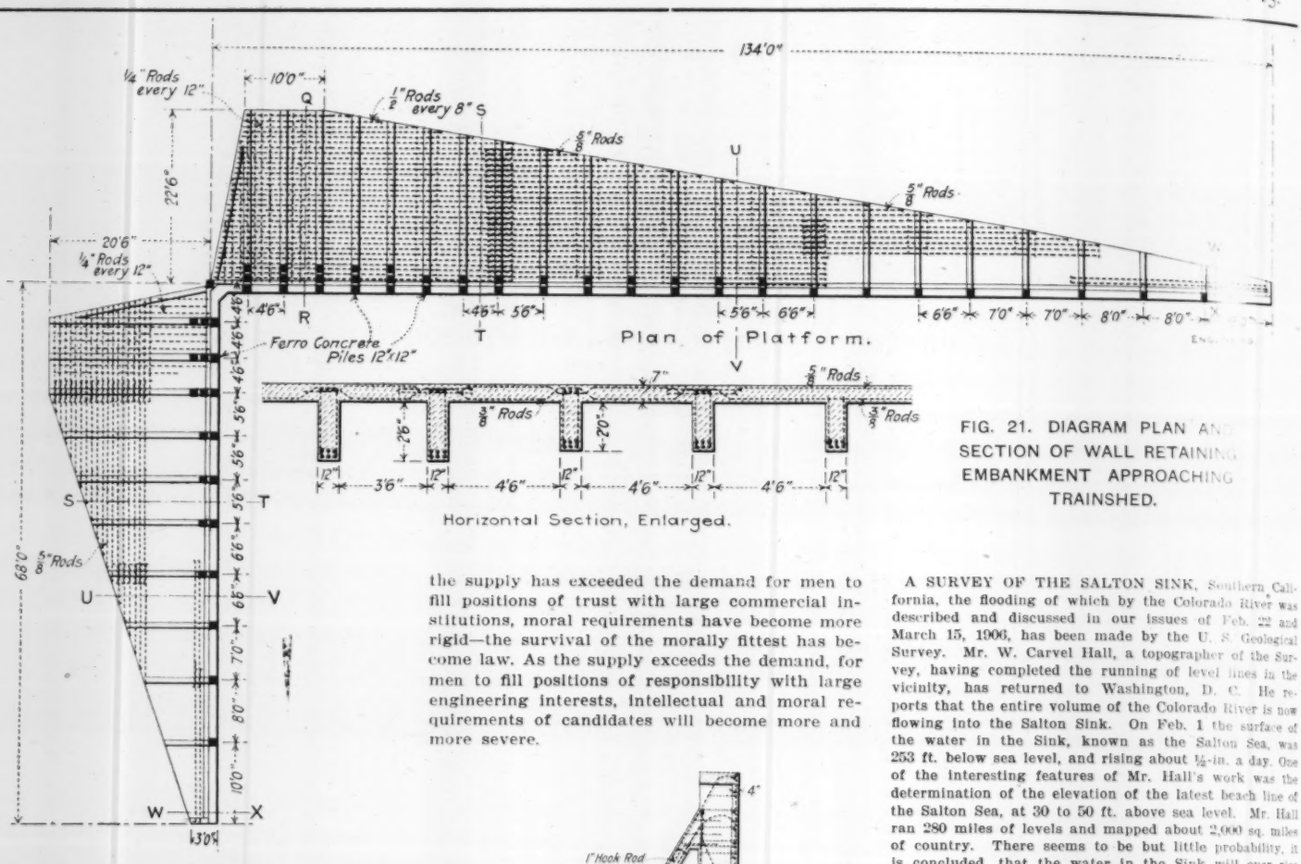


FIG. 21. DIAGRAM PLAN AND SECTION OF WALL RETAINING EMBANKMENT APPROACHING TRAINSHED.

day be exhausting his vocabulary of vile epithets for his chief, should the latter entrust him with an instrument that has seen considerable service in all kinds of weather. It is the instructor's duty to learn to know the characteristics of his students; for intending employers are entitled to know and expect this information when they consider candidates. Aptitude and conscientious desire to make the most thorough preparation his school affords soon differentiates the worthy candidate from the time-server. It is a fraud upon the public to recommend an unworthy student to a position he cannot fill; it is a discredit to vote into the association of the engineering profession at every college commencement young men who have obtained some or all of their credits in the course by dishonest means.

Not large and magnificent buildings, not expensive laboratory equipment, not even faculties, make schools—these only the student body make possible. Thus the responsibility of the engineering schools is the responsibility of the engineering students. One has but to review recent expositions of graft in commercial positions to become convinced that there will soon be an occasional shattered career among engineering students. Honest students have been known to take dishonest members out of their class, lead them to the gate, and make them promise not to return again. This is the only effective "honor system." When the conscientious and thorough student learns that one unworthy man may defeat ten competent men in getting certain positions; when he sees that, in the public eye, there is no difference in the graduates from his school; when he knows that the incompetent student can easily afford to beat down the wages already low; when he begins to realize that he is in direct competition with his unworthy classmate after commencement day; when he feels that to loan his exercise is to give away his purse,—then will he want to insist that there shall be no difference in the work done at school.

The engineering school which makes this stand for independent and thorough work will have an increased patronage of honest students, will have such a demand from engineers and contractors for technical help that it cannot be supplied. As the supply has exceeded the demand for men to fill positions of trust with large commercial institutions, moral requirements have become more rigid—the survival of the morally fittest has become law. As the supply exceeds the demand, for men to fill positions of responsibility with large engineering interests, intellectual and moral requirements of candidates will become more and more severe.

A SURVEY OF THE SALTON SINK, Southern California, the flooding of which by the Colorado River was described and discussed in our issues of Feb. 22 and March 15, 1906, has been made by the U. S. Geological Survey. Mr. W. Carvel Hall, a topographer of the Survey, having completed the running of level lines in the vicinity, has returned to Washington, D. C. He reports that the entire volume of the Colorado River is now flowing into the Salton Sink. On Feb. 1 the surface of the water in the Sink, known as the Salton Sea, was 253 ft. below sea level, and rising about ½-in. a day. One of the interesting features of Mr. Hall's work was the determination of the elevation of the latest beach line of the Salton Sea, at 30 to 50 ft. above sea level. Mr. Hall ran 280 miles of levels and mapped about 2,000 sq. miles of country. There seems to be but little probability, it is concluded, that the water in the Sink will ever rise enough to flood the arable lands of the Imperial Valley, but there is a real danger that the channel of the Alamo River will be eroded so far below the general level of the country that water cannot be taken from it to the lands about Imperial unless new supply canals further up are provided.

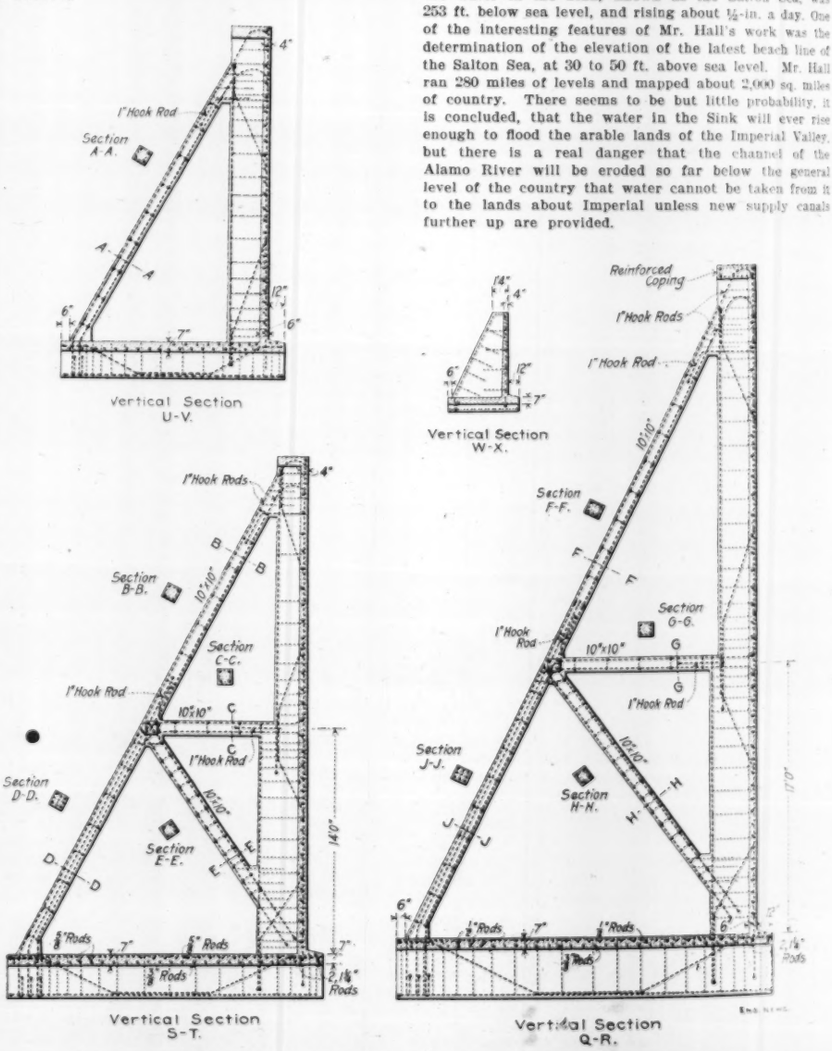


FIG. 22. SECTIONS OF RETAINING WALL FOR TRAINSHED APPROACH EMBANKMENT.

FIELD METHODS OF TRIANGULATION IN THE PLAINS COUNTRY IN MONTANA.*

By John T. Stewart.†

It is the purpose of this paper to describe the field methods of triangulation employed by the author while in charge of a primary triangulation party during the summer of 1904, at Havre, Mont. The object of this triangulation was the establishment of geodetic positions for the control of a topographic survey.

The territory surveyed covered approximately 2,000 sq. miles of broken plains country, lying between the Bear

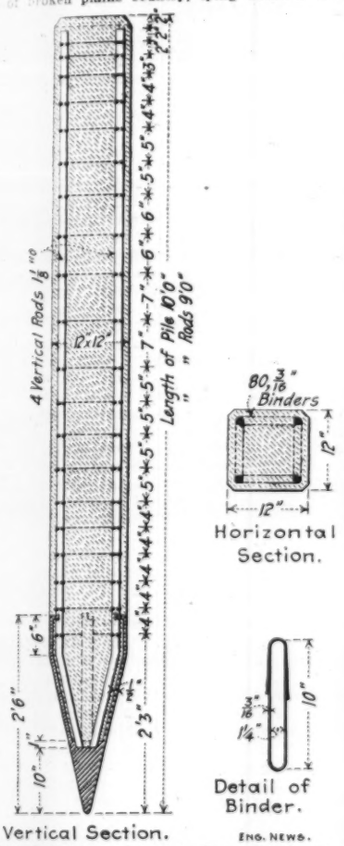


Fig. 23. Reinforced Concrete Pile Used in Foundation Work.

Paw mountains and the international boundary. The Milk River flows east through this area, the entire section being more or less cut up by small streams and coulees. The divides are rolling ridges and highlands, having no distinguishing characteristics and are covered with grass and sage brush, on which immense bands of sheep, attended by a single herder, are pastured throughout the summer season. The bluffs along the river are very abrupt in places, approaching bad-lands formation in others. The elevation is about 400 ft. above the river. Havre having been selected as the outfitting point, on my arrival there, early in July, I proceeded to assemble an outfit suitable for carrying on the work. As the work of triangulation requires a great deal of traveling over the area covered, it was known that the party would be required to subsist itself in the field and a camp outfit would be necessary. The outfit can be described under three parts: 1, Engineering; 2, Transportation; 3, Subsistence.

The engineering part consisted of the chief of party (who was the triangulator or engineer in charge) and his assistant or recorder, with a light team and buckboard for traveling over the country. This buckboard was equipped with a large pine box for the theodolite, the bottom and sides of this box being heavily padded with blankets to lessen the jar on the instrument. Straps were provided by which the digging tools and signal materials could be secured to the body of the buckboard; the seat box served as a receptacle for lunches and water canteens; a 9 × 9 ft. army tent with a canvas floor served the triangulator and recorder as an office and sleeping tent. The tent furniture consisted of a small Sibly stove, a folding table, two folding chairs and a small pine box, known in camp as the stationery or strong box. In this box were kept all notes and records, every man understanding that it was the first article to be looked after, in case of an accident or danger to the camp.

The transportation part consisted of the teamster, one four-horse team and one heavy lumber wagon with a double box. A 45-gallon barrel was carried in the front end of the wagon box, for supplying camp with water when making dry camp.

The subsistence part consisted of the cook, a 9 × 9 ft. army tent, a low three-burner gasoline stove, a folding table 3 ft. square, two large mess chests, and necessary cooking utensils, and the granite iron table ware. The scarcity of wood necessitated the use of a gasoline stove, but this stove did not prove satisfactory for camp purposes, as the currents of air which it was impossible to exclude from the tent, affected the burners to such a degree that it was impossible to secure a uniform heat. While moving camp the stove was carried in a crate; in camp this crate served as the base for the stove, so that it would raise the burners to a convenient height. Each man furnished his own bed; these beds were on the general style of what is known as sleeping bags. They could be rolled up when moving camp, and at night were unrolled and stretched out on the ground, the sleepers getting into them at the head end. The outside covering was waterproof; this was necessary in sleeping away from main camp, as we were without tents and the earth and grass would sometimes be wet. On leaving a supply point, provisions sufficient to last four men 15 days, signal material, and grain were carried on the camp wagon. It was not necessary to provide hay as the stock could obtain sufficient forage by being picketed out at night.

Camp was moved nearly every day from 10 to 20 miles, occasionally it remained three or four days in a place, but the usual procedure was as follows: Breakfast was served at 6 a. m., and immediately the triangulator and his recorder set out in the buckboard, fully equipped for the day. The camp men having received their instructions on the previous evening, proceeded to pack and move camp to the new location, where they were joined in the evening by the others. Occasionally it was necessary for the triangulator to equip his buckboard for a two-days trip and remain away from the main camp over night. Where the drive was not too long it was found convenient to have the camp wagon follow the buckboard and pitch camp near the point where the observing was to be done. This prevented loss of time in going to and from a station, when the observations were not completed the first evening.

In beginning a system of triangulation it is necessary to have given a line of known length, azimuth, and the geodetic position of at least one end. This line on the work is known as the base; the point of which the geodetic position is known is called a station. As there were no given points in this locality, it was necessary to locate a base and determine its length, azimuth and position before the work of triangulation proper could be taken up. It is customary in beginning work of this character to determine the position of the initial station of the base by astronomical observations, but it was unnecessary to make these observations, as it was the intention during the season to connect the work with the monuments on the international boundary (the latitude of which were known) and with Bear Pay Peak, the latitude and longitude of which had been determined by a triangulation system from the south several years previous. An approximate position for temporary use was determined from the Land Surveys.

The apparatus necessary for base measurement consisted of a 300-ft. steel tape, tested and correct at a temperature of 62°; a clamp for holding the rear end of the tape, so arranged that by the motion of a thumb nut, the tape could be taken up or let out; a tape stretcher, with which the operator by revolving a small wooden cylinder and winding up a thin strap could apply tension to a spring balance, to the hook of which the tape was attached. Thus turning on the cylinder would stretch the tape and the balance would indicate the tension. Both the clamp and stretcher had a slot in the bottom part, by which they could be hooked over a 10-penny nail that would hold them in position while in use. Two standardized thermometers were prepared for the field work by binding the thermometer tubes to a piece of lath about 2 ft. in length, the wood being cut away around the bulb of the tube to permit a circulation of air. The object in binding the tube to the lath was to lessen the danger of breakage of the tubes in handling and to render them more convenient for use. By taking hold of a thermometer at the upper end of the lath it could be carried from station to station with the bulb near the level of the tape, and when in use it served as a support when laid across the end of the ties. The long lath also enabled the handling of the thermometer with less liability of the bulb being influenced by the heat of either the lantern or the person of the observer.

A good base line location should be on ground of uniform surface and approximately six miles in length, the two ends being intervisible, as well as commanding a good view of the surrounding country. To obviate the expenditure of unnecessary time and labor in preparing the base for measurement it was desirable that the location should be on a railway tangent. By consulting the maps and profiles of the Great Northern Ry., and a personal reconnaisance of the ground, it was found that the only suitable location for a base was a piece of tangent 5.4 miles in length, 12 miles west of Havre. Camp was moved to the east end of this line and the location of the two stations which were to determine the ends of the base were selected, and named, respectively, East and West base. East base was on a ridge 50 ft. south of the track. West base was on a conical knoll, 400 ft. south of the track.

Stations are marked in plains country by a wrought-iron post 4 ft. in length and 4 ins. diameter, having a bronze top properly marked. Each base station was marked by digging a pit 3 ft. square and 3½ ft. deep. The post was placed upright in the center of this pit, which was then filled with concrete, composed of Portland cement, sand and small boulders. The station was referenced by three posts of the same nature, except that they were set in a pit 12 ins. diameter and 3 ft. deep, being tamped in with earth. These reference posts stood 20 ft. from the station; one on the prolongation of the line, and the other two at right angles to it. The line on which the actual measurements were to be made was across the ends of the ties, 1 ft. south of the web of the south rail. The only work necessary in preparing this line for measurement was to securely nail station boards to the end of the ties at 300 ft. intervals. These were prepared in town and consisted of 1-in. boards, 5 ft. 4 ins. in length and 4 ins. in width. In the center of the board and parallel with its length was nailed a block 12 ins. in length and 1⅛ ins. square. On top of this block was tacked a strip of zinc 10 ins. long and 1 in. wide. At either end of the board and 2½ ft. from the center a 10-penny nail was driven to within 1 in. of its head, to which the clamp and stretcher could be attached.

The tangent selected was shorter than desired for the length of the base, and it was not convenient to have the ends come in the track where trains would interfere with the setting up of the instrument. The measured line was prolonged by the length of the tape beyond the point of curve at either end. The two end stations had to be solidly constructed so that there could be no movement. By means of railway ties and lumber this end station board was securely fixed on the same grade as the ties. Stakes were driven every 50 ft. between the end station and the first station on the ties, and a 10-penny nail was driven to within 1 in. of its head into the sides of the stakes; this nail served to support the tape after leaving the ties. To avoid the irregular temperature caused by the bright, hot sun of the season, measurements were carried on between 10.30 p. m. and 4.30 a. m. The time of beginning was determined by the action of the thermometers. Occasional tests were made, by carrying the thermometer along the track and noting the variation at different elevations along the ends of the ties, and whenever the temperature of the air in the vicinity of the ends of the ties had assumed a uniform condition the work was begun. The tape was run out from the initial end of the line. The rear tapeman carried the clamp, which he fastened to the rear end of the station board, by hooking it over the nail that had been set for that purpose. The head tape man carried the tape stretcher and attached it to the nail in the front end of the next station board. As soon as the clamp and tape stretcher were attached to the station boards the engineer laid his thermometer across the end of the ties near the tape and about 20 ft. from the front end. The rear tape man at the same time laid his thermometer in a similar position with the rear end. The head tapeman then wound up the stretcher, while the recorder passed up and down the tape, watching that it drew straight, and did not catch on spikes and splinters; as it became taut he would catch it between his thumb and finger, raise it up and then drop it; this caused the tape to pull straight and uniform. This was repeated until it was assured that the tape was properly stretched. In the meantime, the rear tapeman by means of the thumb nut on the clamp, brought the zero of the tape to coincide with the initial line on the zinc; during the stretching of the tape he watched that these two lines remained coincident. The head tapeman, not only operated the gear that was stretching the tape, but kept a close watch of the spring balance to see that it stood at a uniform tension of 20 lbs.

When the tape had been stretched to the satisfaction of the engineer in charge, he slipped a small try-square across the station block, on top of the zinc plate and under the tape at the zero of the front end; as he did this he called out "ready." The head and rear tapeman, if the balance and clamp were properly set, answered "all right." The engineer then pressed the tape down on the try-square, saw that the square was set at right angle with the block and marked the station in the zinc, by drawing a fine line, immediately after which he called "all right," ran back and picked up his thermometer, and called the reading to the recorder. As soon as the rear tapeman heard the "all right" call of the engineer he ran ahead and read his thermometer to the recorder. The clamp and stretcher were then unfastened and the

*Abstract of a paper read at the annual meeting of the Illinois Society of Engineers and Surveyors.

†Drainage Engineer (U. S. Department of Agriculture), Paxton, Ill.

tape moved ahead to the next station, where the operation was repeated.

During the first measurement of this line the men at the head end of the tape were supplied with station boards by the teamster who drove along the line with the buckboard. In putting down the station boards care was taken to stretch the tape carefully before the board was nailed, so that the station mark would come in the center of the zinc and not near either end. The laying of the station boards during the progress of the first measurement required some extra time, and the services of an additional man, but it was more economical than laying the boards in the day time, and they came in much better position than if previously laid. The work of measurement was stopped about sunrise. The next evening, the structure necessary to support the tape at the west end, after leaving the track, was put in place and that night the first measurement was completed, and the second measurement was begun at the west end. The second measurement was carried on the same as the first, with the exception that a mark was made on the station line to designate it from the station line of the first measurement, and the distance between the two measurements was recorded at the end of every 3,000-ft. section, as accurately as could be taken under the circumstances. The tape was set back to the station line of the first measurement at the end of the sections. This was done to keep the station marks on the zinc, as the variation in the temperature between the evening and morning measurements made quite a difference in a distance of 3,000 ft. The third measurement was made from the east to the west, the station line of this measurement was marked by still a different character from that of the second. On completion of the base line, the strips of zinc were taken up and sent into the office as a part of the field record. The number of the strip and the character on the lines made a complete record of that station and the difference of the three measurements could be computed in the office, independent of the field notes.

During the progress of the measuring the ends of the measured lines were transferred to the permanent marks of the base line proper. This is done by triangulation. The fixed point, the initial point of the measured line, and the first station of the measured line are taken as the three points of the triangle. The theodolite is set up at all three of these points and the angles measured, and with the length of the first station as a base, the position of the end of the base line in reference to the measured line is computed. A second triangle is formed by using another point on the measured line, which is used as a check against the first.

A complete record of the field work is kept in the notebook. This record gives the number of the tape and a description of the zero points used at each end, the number of the thermometers and their position with reference to the ends of the tape. It shows on what stations the tape is supported by the ties and on what ones supported by the stakes; also the distance apart of the supports; the notes of the end triangulations, and the elevations of the main points along the measured line, as obtained from the railway profile. At the completion of the work this book was sent into the office, where the reductions were made and the length of the base determined from the line actually measured.

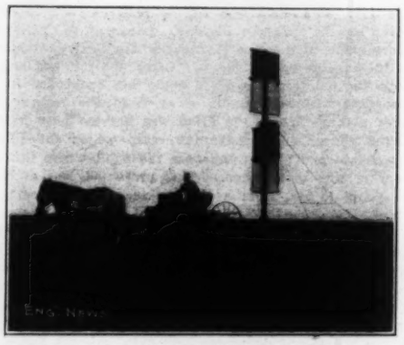
To determine the azimuth of the base, the theodolite was set up in the evening over the east base, properly adjusted and ready for observing. An azimuth mark had been prepared by sawing a slit ⅛ in. in width, lengthwise, through the center of the bottom of a cigar box; this box was securely fastened to a post, approximately half a mile north of the instrument station. At the time for observing, a candle was set in such a position that it would burn down, directly behind the slit in the bottom of the box. The first set of observations were made between 9.30 and 11.30 p. m., and the second set between 2.30 and 4.30 a. m., as at that season Polaris was in the proper position for observing at those hours. The following day a sheet of white paper was placed behind the slit in the box and the angle between the mark and the west base was measured. In determining azimuth, the observer compared his watch the day before the observation at the nearest telegraph station when time call was made over the wire. The comparison was again made on the following day, this gave the correction for the time piece, at the time the observations were made.

In a system of triangulation, triangles for accurate work should have their smallest angle greater than 30° and their longest side to be computed, not more than 1½ times the length of the known side. In a system of triangulation such as was being developed, the length of the sides of the triangles varied from 16 to 24 miles. As the length of our measured base was approximately 5.6 miles, it was necessary before we could begin the actual work, to develop a triangle which would have a known side of 14 to 16 miles.

The process of bringing a measured base up to a base of working length is called expansion. A number of triangulation stations were established in such a position to each other that by forming a proper conditioned triangle, having the measured base as one side, the other sides can be computed, which will in turn give a known side from which a larger triangle can be formed. In this manner the base is expanded into a length suitable for a working triangle.

Before the expansion or triangulation proper can begin it is necessary to select stations and erect signals. The method of locating stations is to reconnoiter the surrounding country carefully from a station already established, select and make notes of such points as apparently are good station locations. This work was very difficult in this region for the reason that there were no prominent peaks or ridges, although the country was rolling and somewhat hilly; the ridges and hills all presented about the same appearances, and there were no distinguishing features in many localities by which one could look for 15 or 20 miles and locate a point and then be reasonably sure he could find it. A point having been determined on for a new station, the triangulator with one assistant would start early in the morning, taking the buckboard and all necessary material, and endeavor to reach the point selected. The point having been reached, the country in all directions would be reconnoitered, if a good view could be had in the desired directions, and other suitable points sighted; the station would be located and the signal erected.

It often happened upon reaching a point selected that it was found unsuitable for a station, the view being cut off in some direction in which it was necessary to sight. Then would follow a long, tedious search for a position that could be used. This hunt consisted in driving from ridge to ridge and studying the surrounding country with field glasses. In some localities a suitable point could not be found from which the desired sight could be had, this would then necessitate a change of plans, causing us to drop back and put in an extra station in order to get a new system of triangles in proper shape to swing



Signals for Triangulation Survey in Montana.

around the ridge that could not be seen over. As the triangulation system is adjusted in the office, by the method of least squares, it was not only necessary to locate the stations so that ill-conditioned triangles would be avoided, but so that the triangles would combine into proper figures for adjustment, such as squares and polygons.

This work of expansion is the same as that of the main system, with the exception that the triangles are smaller. The object being to increase the length of the sides of the triangles regardless of the area of country covered. As the topography of the country was such that large triangles were impracticable, the expansion of the base did not require a great amount of work.

Signals were made of sawed lumber. The targets (shown in the accompanying cut) were of cloth, 3 ft. wide and 5 ft. in length, the upper half being black and the lower half white. They came ready for stretching, which was done by slipping a light strip of wood through a hem at either end, another through the center, and one through a hem on either side. By catching these strips at the ends, they were drawn into a rectangular frame, having a cross brace at the union of the colors; they were then fastened with nails, after which the target was ready for nailing to the upright. The upright was formed by two 2 × 4 timbers 14 ft. in length. A straight corner on one of these timbers was selected as a center line of the signal, after which they were spiked together, the bottom of the timber carrying the center line being stepped one foot above the bottom of the other. Two targets, their long sides vertical, were then centered and nailed to the upright at right angles to each other. A cross block 1 ft. in length was nailed to the upright between the targets. The signal was then raised, the center corner being placed on the center of the station post, where it was held in a vertical position by three wires fastened to the upright above the cross block, and anchored in the ground. These wires at the cross block formed an angle of 120° with each other and 45° with the upright. The anchor was a 2 × 4 stick, 4 ft. long, buried in a trench 12 ins. deep, the course of the trench being at right angles to the wires. After the signal had been raised and anchored it was plumbed and tightened by twisting the wires with a pick ha[ndle]. The foot of the upright, half of which rested on [the] the post, the other half extending down the p[ost] surface, was securely boxed, to prevent the s[ign] the center during high winds. This boxing w[as] ar-ranged that when it was necessary to take dow[n] sig-nal to set up the instrument by knocking off [a] short board, the signal could be slipped from the pos[t] laid down. When the observing was completed it [was] be raised and slipped back into place, and by ren[ew]ing this board it was again in proper position to be sig[ht] from other stations. Before leaving the signal, a [piece] of barb wire was drawn around the outside of the [four] wires 3 ft. above the surface. The object of this [was] and also the using of barb wire, was to prevent [cattle] from rubbing on the signal or its guys. A sign[al] up with smooth wire would be rubbed down with[in a] few days. Two men with the conditions of digging [usu]ally found could set the station post and erect a [sig]nal in three hours.

The instrument used was an 8-in. theodolite [read] by micrometers to single seconds. The instrument when cased was in three parts: The tripod, the circle and the telescope. In setting up the instrument, the tripod was centered over the station with the screws loose; after the head had been centered and the legs firmly planted, the screws were tightened. The circle was then set on the tripod, where it was in no way attached but remained in place by its own weight. After the circle was leveled, the leveling screws were clamped, the telescope was then placed in the wyes, after both wyes and spindle had been wiped. A large umbrella was placed over the instrument to protect it from the sun, while a sheet of heavy canvas 9 ft. in length and 6 ft. in width was stretched on the windward side of the instrument to protect it from the wind. Sunshade and windbreak were held in position by ropes.

On account of the unsteady condition of the atmosphere, observing could not begin until about an hour before sunset, and lasted about an hour after sunrise. The method of working was to get to the station in the afternoon, set up, and be ready for observing as soon as the signals came into view and observe as long as the light lasted, then be ready at sunrise and continue the observations until the station was completed or the signals disappeared in the haze. In case the observing was not completed in the morning it would necessitate our remaining there until evening, when the work was again taken up. All signals visible from a station were sighted and angles read regardless of their position or distance. Angles were also read on prominent buildings, watertanks or any natural objects, which could be recognized by the topographer. Section lines were also tied in, when it was practicable to do so.

The most serious difficulty in observing this country was in finding the distant signals, as there was scarcely a station which did not have at least two or three signals that were necessary to be sighted, but were invisible to the naked eye; and on account of the uniform appearance of the section in which they were located it required a long, tiresome search with the telescope to locate them. That is, it required a long time when compared with the amount of working time that was available each day. After the signal was once located, the line was marked by sticking a peg into the ground about 100 ft. from the station. At the next pointing the telescope was sighted at this peg, then by elevating the objective end of the glass the signal was quickly found. After once being located, they could be found by the angles, but setting off an angle consumed too much time. When signals are in view, no time can be wasted by slow methods. The method of observing was to focus the telescope on a signal, about the average distance at which the sights were to be taken, then select the sharpest and clearest signal for an initial point, bisect it with the vertical hair, read both micrometers, unclamp and turn the telescope to the right, pointing on the next signal, again reading both micrometers. While sighting, the name of the signal is called to the recorder, as soon as the micrometer is read, the micrometer letter with the reading is called; while the observer is pointing on the next signal, the recorder averages the two micrometer readings and works out the angle of the station with the initial station. All signals on the horizon being read to the right, the last pointing is taken on the initial station. This reading, compared with the first, will show if there has been any movement of the instrument during the readings. The telescope is then reversed, the instrument turned 180° in azimuth, beginning with the initial station, all signals on the horizon are read to the left, again closing on the initial station. The readings to the right are known as the first half, those to the left as the second half, the two halves form a set, and the sets are designated by the number of the order in which they are taken. As soon as the first set is completed, the lower plate is unclamped and shifted approximately 36° to the right, then another complete set is taken. The lower plate is again shifted 36° to the right and proceed with another set. This is continued until five sets have been taken, which completes the work on the station. When through observing on any signal,

there have been twenty readings made, or a reading on every 18° on the circle. Hence on a station where there are eight signals visible, which is not an unusually large number, there have been, including the closing on the initial point, 161 readings made to complete the station.

To make a micrometer reading, the degrees are taken from the circle, the ten minutes from another point on the circle, the signal minutes, from the comb scale; and the seconds, from the head of the micrometer's screw. This makes four places the eye has to catch to make a single reading. Considering the time spent in reversing the telescope, shifting the circle, occasionally adjusting the sunshade and the wind break, it can be readily seen that when the time for observing does not exceed two hours out of the day, a triangulator to complete an eight-signal station in a day, has no time to play while the signals are in view. A good observer in practice, after his signals have once been sighted, will call off a micrometer reading every 30 or 40 seconds. A good recorder can record these readings, compute the average of the two micrometers, and the angle with the initial station, so that when the observer is through he can see at once how his angles are running in different sets. The allowable limit of error in triangle closure was five seconds, after correcting for spherical excess.

The work was greatly delayed in the latter part of the season by smoky, hazy weather. The entire camp lay at the West Cherry station for eleven days, trying to make observations that were completed in an hour after the haze lifted. There were a number of days when it was impossible to sight signals five miles distant. The work was begun about the 20th of July and completed November 5th. The closures were all good, and the accuracy sought for was obtained. The area should have been covered in less time, although it was the best that could be done under existing conditions.

SHADE TREES ON MASSACHUSETTS STATE HIGHways were planted in 1905 to the number of 3,239 and in 1904 to the number of 726. The varieties planted in greatest numbers during 1905 were Norway, white and sugar maples in the order named, numbering 1,594 in all, and (816) elms. Vines to the number of 300 were also planted in 1905. Mr. Edward W. Breed, of Clinton, Mass., is Forester to the Commission, and the foregoing statements are based on his report, published in the report of the Massachusetts Highway Commission for the year 1905.

SURVIVORS OF THE COURRIERES MINE DISASTER appeared at the shaft on March 30, twenty days after the explosion. While a salvage party was at work in one of the shafts, a party of thirteen men came toward them out of a distant gallery. They had lived for the three weeks since the explosion in a part of the mine which the authorities responsible for the rescue work had declared impassable. Only one of the party had received injuries in the explosion. It is also reported that a number of bodies recovered on the same day, March 30, were pronounced by physicians to have been dead not over a day. There is much feeling against the mine authorities for laxity and inefficiency in the conduct of the rescue work. Of some 1,200 entombed by the explosion, about 700 still remain to be accounted for.

DIFFICULT WATERPROOFING OF A CONCRETE PASSENGER SUBWAY UNDER RAILWAY TRACKS.

The accompanying illustrations show a neat example of passenger subway construction under railway tracks, to which additional interest is contributed by the difficulties encountered in the waterproofing work. This subway gives passage to pedestrians under the tracks of the South Side R. R. at the Metropolitan Race Track at Jamaica, Long Island. Fig. 1 is a general plan of the structure and Fig. 2 shows the essential structural details. The entire structure is built of broken stone concrete strengthened in the roof by embedded steel beams under the rails; the mixtures used were 1-2-4 for the roof and stairs and 1-3-5 for the walls and floor. The plans were prepared under the direction of Mr. J. R. Savage, Chief Engineer, Long Island R. R., and the work of construction was in charge of Mr. David Beaver, Assistant Engineer.

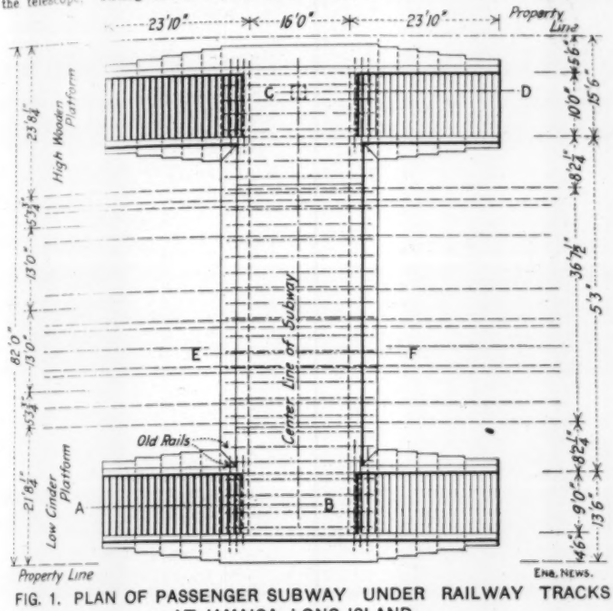


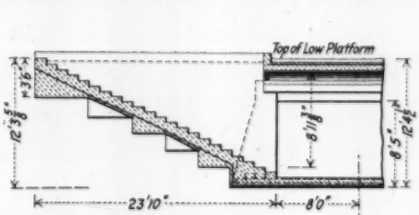
FIG. 1. PLAN OF PASSENGER SUBWAY UNDER RAILWAY TRACKS AT JAMAICA, LONG ISLAND.

The detail drawings of Fig. 2 show clearly the location of the waterproofing. It was in the placing of this waterproofing that the principal difficulties were encountered. The excavation for the subway was through gravel, and reached a depth of 11 ft. for the main subway and of 15 ft. for the sump. As the excavation proceeded several springs were encountered, the water from which, when allowed to rise, came up from 5 to 6 ft. above the subway floor and some 9 ft. above the sump bottom. The excavation was kept drained by pumps to a level below the subway floor. This floor consists of a layer of waterproofing embedded in mortar and covered by concrete reinforced by steel rails. The waterproofing layer consisted of six layers of Hydrex waterproof felt cemented together by hot Hydrex compound. On top of the waterproofing came a 1 to 2-in. coat of cement mortar and then the concrete proper.

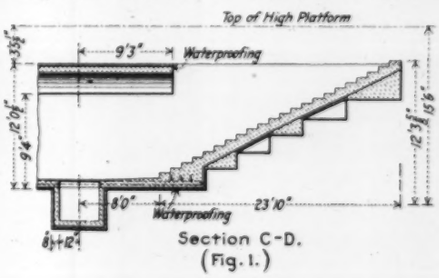
The side walls were constructed of one course of brick, with struck joints on the inner surface, against which to apply the waterproofing, a new interlapping and reinforcing method, at the angle where the floor waterproofing and the wall waterproofing meet. These brick walls also served as one side of the form for the concrete of the walls proper of the tunnel. The floor and walls being completed, it was then a simple matter to construct the roof (jack-arches leveled off), over which the waterproofing was continued and covered with concrete, with sand under ballast on top, in which were set the ties and rails of the several tracks of the road passing over the tunnel. At one time during the construction the earth, from weakening by water, fell in against and broke down the brick backing-wall, taking the waterproofing with it and allowing the inrush of water to spread several feet over the bottom of the tunnel. This wall was built in 5-ft. heights at a time.

As indicating the water pressures, a laborer accidentally punched with a crowbar a hole through the waterproofing stratum and the cement mortar covering, whereupon the water spouted up nearly 3 ft. The hole was successfully patched and covered with cement mortar and properly protected. When the tunnel was completed and the pumps stopped, the water rose from 5 ft. to 6 ft. about the walls, or 9 ft. from the bottom of the sump, and so remains. The structure, however, though completed some time ago, has been tight, with no percolation of water, and is satisfactory.

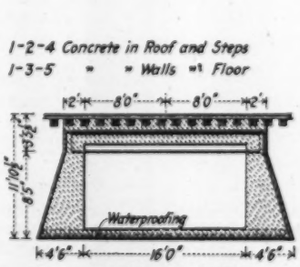
The waterproofing of the structure was designed by the Hydrex Felt & Engineering Co., of New York, N. Y., to whom we are indebted for the information from which this description has been prepared.



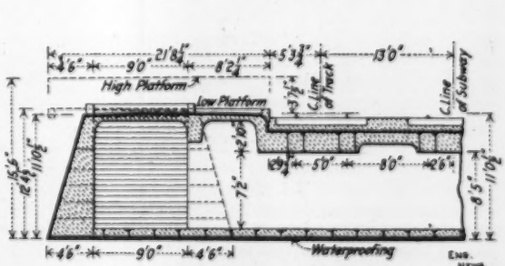
Section A-B. (Fig. 1.)



Section C-D. (Fig. 1.)



Section E-F. (Fig. 1.)



Part Longitudinal Section.

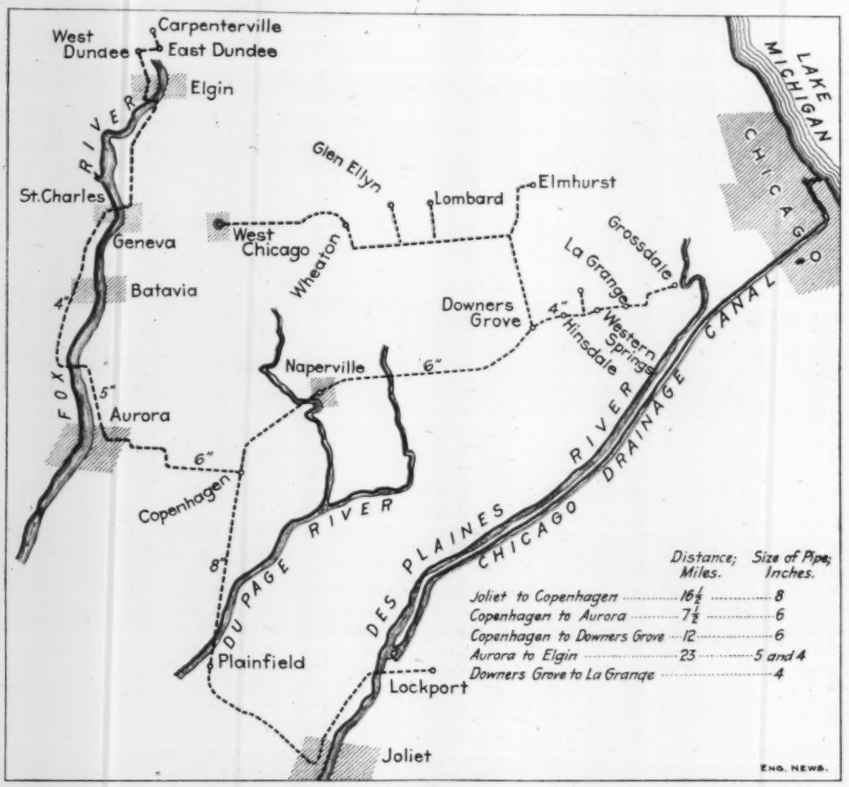
FIG. 2. DETAILS OF PASSENGER SUBWAY AT JAMAICA, LONG ISLAND.

A HIGH-PRESSURE GAS DISTRIBUTION SYSTEM.

There is in this country a growing tendency to distribute gas at high pressure for considerable distances, and one of the largest systems of this kind is that operated by the Western United Gas & Electric Co., having its headquarters at Aurora, Ill. This company serves about 19,600 consumers in 25 cities, towns and villages, by means of pipe lines aggregating 431 miles in length. These towns have an aggregate population of 140,000, and the extreme distance between them is 52 miles. The gas is used mainly for domestic heating, lighting and cooking; but also to some extent for street lighting and for power purposes, driving gas engines, etc. The accompanying map shows the routes of the pipe lines, with their sizes and lengths. For particulars respecting this system we are indebted to Mr. H. L. Rice, General Manager of the Western United Gas & Electric Co., and we have also drawn part of our information from a paper read by him before the American Gas Light Association. Mr. P. O'Malley is Superintendent of the Works, and Mr.

Howard G. Stillson is Superintendent of Distribution.

In 1902 the Aurora Gas Light Co. built a line 12 miles long, running north in the Fox River valley and serving four towns; in 1903 the La Grange Gas Co. built a line, and these have been connected up and extended by the present company. There are now about 100 miles of high-pressure main pipe line, 286 miles of low-pressure mains, and 45 miles of direct high-pressure distributing mains. The high-pressure pipes are of steel, with screw joints, and range from 8 ins. down to ¾-in. diameter. The low-pressure pipes are of cast iron for diameters of 16 ins. down to 3 ins., the smallest low-pressure pipes being 2-in. steel distributing mains. The long-distance mains are generally laid along the roads, in which case the company has to obtain the frontage consent on one or other side of the road. In a few instances the mains are laid across the fields, and in this case special arrangements are made with the owners of the land. The arrangements vary, but provide that the pipe may remain where located for a term of years, during which period the company may have access to it for repairs. The high-pressure lines are tested during construction to 60 or 70 lbs. pressure by compressed air; they are laid in trenches about 30 ins. deep, and there has been no trouble from condensation in these lines.



SKETCH MAP OF GAS DISTRIBUTION SYSTEM OF THE WESTERN UNITED GAS & ELECTRIC CO.

The gas pressure is 30 lbs. per sq. in. in the long-distance lines, while for the distribution systems of the towns it is reduced to about 3 ins. of water. The district governor used is that of the Johnson-Reynolds Co., of Anderson, Ind. The same company's regulator is used where the high-pressure gas is delivered directly to the consumer's house. Beyond this is the ordinary type of house meter, but between the regulator and the meter there is provided a safety blow-off in the event of the pressure creeping up.

About 20% of the consumers are dependent entirely upon this system, and when the manufacture of gas is ultimately concentrated at one station at Joliet, as noted below, all the other cities and towns mentioned will be dependent upon this system. The annual consumption of gas is about 550,000,000 cu. ft. per year, of which the towns dependent on the line represent a large proportion, although many of them are still in process of development as gas-consuming territory. The high per capita consumption of gas in the suburban towns is indicated by the following statement:

Hinsdale (district governor station), with a population of 3,100, contains about 600 houses, has 554 gas meters and consumes 15,750,000 cu. ft. per year. Western Springs (direct high-pressure), with a population of 750, contains 140 houses, has 126 meters and consumes 3,430,000 cu. ft. The possibilities of high-pressure work in small towns are shown by Plainfield, a farming town of 1,000 population, with about 195 possible consumers. It was piped in 1905 with 1-in. and ¾-in. pipe, radiating from the central trunk line, at a total cost of only $1,290, and already has 150 consumers. As an example of the larger towns, Aurora (population 30,000) has 5,000 consumers, using 125,000,000 cu. ft. of gas.

The gas is generated by works at four points. Coal gas plants at Joliet, Elgin and La Grange pump their surplus gas into the pipe line, and at Aurora there is a combination coal gas and water gas plant which delivers gas to the pipe line or draws from the line, according to the pressure conditions. The plants have a total generating capacity of 2,705,000 cu. ft. per day, divided as follows: Joliet, 800,000 cu. ft.; Elgin, 500,000 cu. ft. (and 500,000 cu. ft. of water gas); La Grange, 225,000 cu. ft.; Aurora, 330,000 cu. ft. coal gas and 350,000 cu. ft. water gas. There are gas holder stations of 1,200,000 cu. ft. capacity at Joliet, Aurora, Elgin and La Grange. District governors reducing the pressure in the distribution mains are located at Batavia, Geneva, St. Charles, Hinsdale and Downer's Grove; all the other towns have direct high-pressure in the mains. At each of the four generating stations there is a gas pumping plant, consisting of straight-line compressors operated by steam. These are Ingersoll-Rand compressors, each having a steam cylinder 10 × 14 ins. and a gas cylinder 13 × 14 ins., and with a capacity of 270 cu. ft. of free gas per minute while operating at a speed of 130 revolutions per minute. They can compress gas to a pressure of 40 lbs. per sq. in. when working under a steam pressure of 80 to 100 lbs. There are two of these machines at Aurora, two at Joliet and two at La Grange. The governor used is of the flyball type, regulating the speed, according to the demand for gas, up to the maximum speed of 130 revolutions; but should a gas main break the engine would not race, as the governor would shut it down when this maximum speed was exceeded. The governor pulley has a safety-stop attachment by which the machine would be stopped in case the governor belt should break. No figures of value as to the cost of pumping are available, as the conditions are not favorable to economical working. There are four separate stations, and the compressors are not economical in steam consumption. With one large and economical plant, it is estimated that gas can be pumped at 60 to 75 lbs. pressure at a cost of 2 cts. per 1,000 cu. ft., including the maintenance of the station.

Tests of the power required to pump 10,000 cu. ft. per hour of gas at 63° F. against gage pressures of 10 to 42 lbs. per sq. in. gave a flat curve ranging from 7½ HP. at 10 lbs. pressure to 13 HP. at 22 lbs., 18½ HP. at 32½ lbs., and 23½ HP. at 42 lbs. Tests of the flow of gas on the line from Aurora to Elgin, equivalent to 21½ miles of 4-in. pipe, and tests of the flow of gas through 1,048 ft. of 1-in. steel pipe, are given below. In the former case all consumers were shut off the line as far as St. Charles, at which point the pressure was taken, the pressure at Elgin (as shown by the rise at the gasholder) being about 2 to 3 ins. of mercury. In the latter case the pipe was laid around the Aurora gas works with such long curves that they could practically be ignored.

In regard to the effect of compression upon the quality of coal gas and water gas, Mr. Rice states that there is already a tendency towards higher pressures than those now employed, and that there is immediate need of definite knowledge as to the effect of this higher compression on the candle-power and especially as to the heat-units, as direct candle-power is becoming of less importance to the consumers.

Working with two or more stages in compression instead of one, common practice in other pressure work, six times the pressure can be secured with about twice the horse-power. Six times the pressure means five times the delivery. With economical engines and compressors the steam cost of the additional horse-power will be still further reduced in comparison with present installations. These are the every-day facts of the natural gas engineer, who pumps his product at greatest economy at about 300 lbs. pressure.

It is proposed to economize in the cost of producing gas by concentrating the manufacture in one large plant at Joliet, and pumping with an initial pressure of 50 lbs. per sq. in. This would involve the re-pumping at Aurora of gas for Elgin, if the present route is maintained; but a new and more direct route is proposed on which this would not be necessary. The water gas plants at Aurora and Elgin would be maintained for an auxiliary supply in case of necessity. The present gasholder stations would also be maintained, and perhaps be supplemented by others, but nothing has yet been determined as to this feature of the work.

In addition to its gas plants, the company operates a modern electric generating station at Aurora, supplying electric light and power within the city. It does not light the streets, however, as this is done by the municipal electric light plant.

TESTS OF FLOW OF GAS IN PIPES

21 miles of 4-in. pipe				1,048 feet of 1-in. pipe	
Gage pressure		Delivery per hour		Gage pressure	Flow per hour
Aurora lbs.	St. Charles lbs.	Actual cu. ft.	Theoretical cu. ft.	lbs.	Actual cu. ft.
15	7½	8,400	8,528	1.20	550
20	9½	9,300	10,374	4.51	1,350
35	....	16,170	15,645	10.64	2,390
50	30	22,860	20,743	17.90	3,550
				25.00	4,580
				35.00	6,000
				40.00	6,977

Theoretical cu. ft.
618
1,402
2,381
3,258
4,295
5,520
6,141

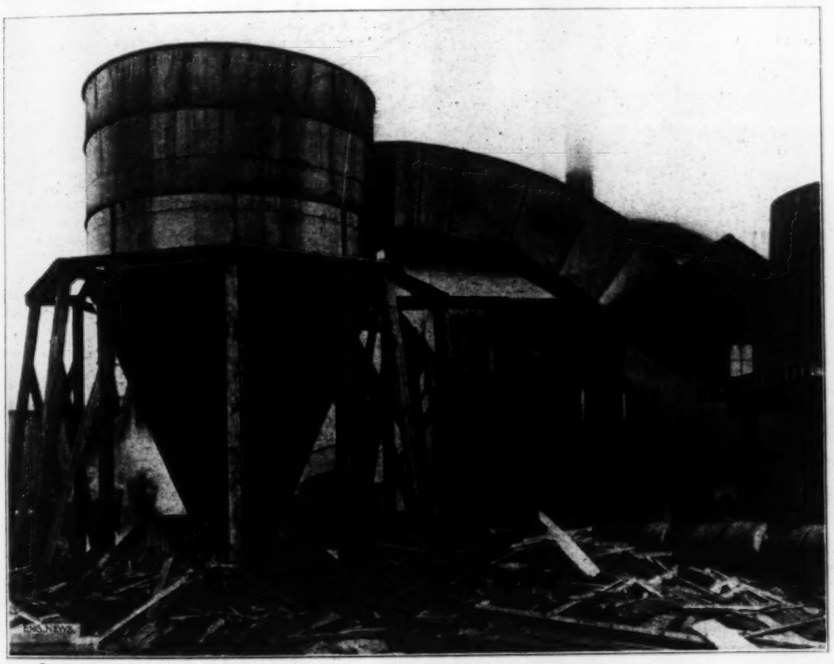
A CENTRIFUGAL CINDER SEPARATOR FOR POWER-PLANT SMOKE.

The Portland Consolidated Railway Co., of Portland, Ore., which operates the street railways of that city, has a power plant of 3,500 HP. capacity at East Portland. The fuel burned under the boilers of this plant is saw-mill refuse: wet sawdust and wood ground up in the log. Some 500 tons per day is burned. Residents within half a mile of the plant have long been troubled by cinders from the power-plant stacks, which collected on their sidewalks and porches and blackened the clothes on their clothes-lines. A lumber mill alongside the power-house has had thousands of dollars worth of lumber refused by inspectors because it was blackened in spots by cinders dropping on it. During the past year a cinder-separating installation has been put in by the railway company, and in several months' working it has proven completely successful.

This installation consists of an induced-draft plant discharging through a large steel separator of the same form as shavings separators used on saw-mills. The separator is shown in the half-tone view herewith. The induced draft is obtained by a 20-ft. steel plate fan connected to the boiler uptakes, which discharges into a steel plate flue 8 ft. in diameter leading tangentially into the separator. The latter is simply a vertical cylinder of steel plate, 32 ft. in diameter, partly closed at the top so as to leave a 16-ft. central opening, through which the smoke escapes. Inside the cylinder is a spiral of the same diameter as the smoke outlet. The bottom of the separator forms a huge conical hopper for receiving the cinders. The height of the separator, from bottom of hopper to discharge opening, is 56 ft. The smoke, entering the separator tangentially, describes a spiral path and loses velocity until it passes up through the open top of the separator. The maximum velocity of flow of the gases in the flue leading from fan to separator is about 5,200 ft. per min.; the velocity at the discharge opening, which is twice the size of the flue, is therefore about 1,300 ft. per min. The cinders are dropped in the range between these two velocities. As the gases lose velocity, the cinders, being heavy, drop in a spiral path to the hopper-shaped bottom. Here they collect until removed by a steam-driven conveyor, which takes them to the boiler furnaces for burning. The cinders collected vary in size from very fine particles up to pieces about 1 in. long.

The separator plant described is installed in duplicate, the boiler plant being divided into two equal halves. Each fan and separator thus corresponds to a steaming capacity of 1,750 HP.

Since the installation of this separating plant the cinder nuisance has been wholly abated. A distinct increase in boiler economy has also been observed, due, no doubt, to the uniformity of the induced draft as compared with the former stack draft; the boilers are also said to have a larger capacity than before. The separator installation cost in the neighborhood of $19,000. It is stated by the railway company that the increased capacity of the boiler plant more than pays for the separator installation. The work was built and put in by the W. G. McPherson Co., of Portland, who kindly supplied the data for the above description.



CINDER SEPARATOR AT THE EAST PORTLAND POWER STATION OF THE PORTLAND CONSOLIDATED RAILWAY CO., PORTLAND, ORE.

THE BACTERICIDAL ACTION OF COPPER.

A good deal has been heard of late regarding the use of copper for the treatment of water infected or in danger of being infected with typhoid germs. The subject was discussed from various points of view at the annual meeting of the New England Water-Works Association last September (see Engineering News, Sept. 21, 1905). Some detailed studies of the action of copper on bacteria, by Mr. H. W. Clark, Chemist of the Massachusetts State Board of Health, and Mr. Stephen DeM. Gage, Biologist of the Lawrence Experiment Station, Lawrence, Mass., were reported in "The Journal of Infectious Diseases," Supplement No. 2, February, 1906. From a reprint we take the following information.

The experimental data fall under the heads of waters treated with definite amounts of copper as copper sulphate, and water in contact with metallic copper so as to allow the absorption by the water of unknown amounts of copper. In addition, studies were made of the action of other salts often used in water purification, such as ferrous sulphate and aluminum sulphate, in order to compare their efficiency with that of copper sulphate. As to the general method of study employed and what the authors term a "weak point" in the conclusions of Moore and Kellerman (U. S. Department of Agriculture, Bureau of Plant Industry, Bulletin No. 64, 1904; also see Engineering News, May 26, 1904, p. 496), we may quote from the paper as follows:

The difficulty of isolating typhoid from mixed cultures in water, and the preponderance of other germs in sewage-polluted water, rendered it necessary to attack our problem in a roundabout manner. The method which has given the most reliable information at Lawrence, in investigations of this character, has been to study the relative viability of different laboratory cultures of both B. Typhosus and B. coli, to study the viability of the colon bacillus in a natural state under similar conditions, and from the two sets of experiments to draw inferences as to the viability of the typhoid bacillus in nature under similar conditions.

The weak point in the conclusions of Moore and Kellerman with regard to the destruction of typhoid by copper is that they were drawn from analyses in which the largest amount of water tested was 1 c.c., and the usual amount tested was less than .01 c.c. It is generally conceded, especially when dealing with laboratory cultures, that the great majority of the typhoid bacilli are quickly destroyed by conditions unfavorable to their growth. It has also been repeatedly shown that a few germs are much more resistant than the majority, and may survive even under the most unfavorable conditions for many days. All epidemiological evidence points to the conclusion that the germs which are able to live under unfavorable conditions are also extremely pathogenic, and that, while it may help to destroy the majority of the bacilli, no method of sterilizing water is thoroughly effective unless it will accomplish the destruction of the especially resistant individuals.

It is unsafe to conclude that because a certain species of bacteria, especially a pathogen like B. typhosus, is not found in a loopful of the water, or even in 1 c.c., that there is no danger from the use of that water. The average drinking-glass holds about 300 c.c., and until repeated tests of volumes as large as 100 c.c. have been made and the germ proved to be absent, the water under observation cannot safely be said to be free from the test forms.

Most of the remainder of the 30 pages is taken up with detailed descriptions of the experiments and the results obtained. The authors made the following statement regarding the relative efficiency of the other salts tried and copper sulphate, and then drew their final conclusions, as follows:

From the two experiments made with sulphate of alumina and ferrous sulphate, these two salts appear to have about the same action on the bacteria and B. coli as have equal strengths of copper sulphate.

Judging from the results of experiments comparing metallic copper with other metals, all of the metals tested seem to be about equal in their effect on the numbers of bacteria in waters with which they are in contact. In one experiment the water in contact with zinc became sterile after about three weeks, while the numbers of bacteria increased in the water which was in contact with copper, and with all the metals, excepting zinc, a few bacteria were alive after 132 days.

Based on the disappearance of B. coli in 1 c.c. the metals in one experiment ranked: Zinc, 10 days; iron, 15 days; tin, 41 days; aluminum, 41 days; copper, 43 days; lead, 97 days; and in the other experiment: zinc, 10 days; copper, 10 days; tin, 23 days; iron, 23 days; lead, 23 days; aluminum, 31 days.

CONCLUSIONS.

In conclusion, the writers believe that the treatment of water with copper sulphate or by storing it in copper vessels has little practical value, for the following reasons:

(1) The use of any method of sterilization which is not absolutely effective is dangerous in the hands of the general user, tending to induce a feeling of false security, and leading to the neglect of ordinary precautions which would otherwise be employed.

(2) The removal of bacteria, B. coli and B. typhosus, by allowing a water to stand in copper vessels for short periods, while occasionally effective, is not sure, and the time necessary to accomplish complete sterilization is so long that the method would be of no practical value to the ordinary user. Furthermore, metallic copper seems to have little more germicidal power than iron, tin, zinc, or aluminum.

(3) Although the removal of B. coli and B. typhosus is occasionally accomplished by dilute solutions of copper sulphate, these organisms may both live for many weeks in water containing copper sulphate in greater dilutions than 1:100,000; and in order to be safe dilutions of 1:1,000 must be used, in which case the water becomes repugnant to the user because of its strongly astringent taste.

(4) In some instances very dilute solutions of copper sulphate or colloidal copper absorbed from contact with clean metallic copper, appear to have a decidedly invigorating effect on bacterial activity, causing rapid multiplication, when the reverse would have been true had the water been allowed to stand the same length of time without any treatment.

A LARGE POWER-DRIVEN PIPE-TAPPING MACHINE WITH SPECIAL SLEEVE AND VALVE CONNECTION.

Among the many ingenious labor-saving and time-saving appliances at the disposal of water-works superintendents, none is of more importance than that for tapping water mains and making new connections. By the aid of these machines branch connections of any size, from a small domestic house service to a 48-in. branch from a main of the same or greater diameter, can be made, and that without shutting off the water in the main being tapped. The Water-Works Equipment Co., of 180 Broadway, New York City, is now equipping its tapping machines of various sizes with gasoline engines as a substitute for hand power. The accompaning illustration shows one of these tapping machines, equipped with a 6½-HP. Mianus gasoline engine, making a 30-in. connection with a 30-in. water main at Trenton, N. J. The engine was secured to the frame of the machine by four bolts. The gear of the engine shaft meshes into the large gear on the frame of the tapping machine. The machine and engine weigh about 5,500 lbs.

POWER-DRIVEN TAPPING MACHINE MAKING A 30-IN. CONNECTION WITH A 30-IN. WATER MAIN AT TRENTON, N. J.

The sequence of operations in making the 30-in. connection at Trenton was as follows: A 1½-in. hole was first cut in the main by means of the leading-off drill; then a 4-in. hole was made by means of a 4-in. cutter, thus allowing the main shaft of the large cutter to be inserted in the pipe. This cutter was then operated until a 30-in. hole was cut in the shell of the pipe, the piece of pipe removed having been held by spring catches on the shaft where the latter was inserted in the pipe. To cut the 1½-in. hole and the 4-in. hole took 30 minutes, and to cut the 30-in. hole took 59 minutes. During the whole operation 2½ gallons of gasoline were consumed, which, at 15 cts. per gal., cost about 45 cts.

For the benefit of those not familiar with the process just described, it may be explained that to tap a main under pressure a sleeve and valve are used. The company already named uses any standard valve, one end of which is bolted to a special which may be best described by calling it a T-branch, in which the cross of the T is replaced by a half sleeve, provided, of course, with flanges. The other half of the sleeve, when bolted up, surrounds the main at the point where it is to be tapped. The sleeve and gate valve being properly attached to the main, and the valve opened, the tapping operations are carried on within the branch, as already described. When the piece of pipe cut out by the machine has been removed past the gate, the latter is closed until the machine has been removed and the outer end of the valve has been connected up with the branch line.

Two special features of the sleeve supplied by the company already named are the flanged joint and the provision for using cement instead of lead for filling that portion of the space between the cast-iron sleeve and the main pipe lying between the bells on each end of the sleeve. The sleeve flanges, instead of bearing against each other at the bolts, are tapered off so as to form, when bolted up, a space which is V-shaped in cross-section. The joint faces are about 1½ ins. wide, and between them a ¼-in. lead gasket is placed. When the bolts are tightened more pressure is brought upon the joint faces and the gasket than would be the case if the full face of the flanges were in contact.

As to the other special feature of this sleeve, it is obvious that a large amount of lead is saved by using cement instead of lead between the hubs of the sleeve, assuming that it is necessary to fill all this space with something. The hubs or bells have a depth of 4 ins., and are yarned or leaded the same as any cast-iron pipe joints. On the 30-in. connection at Trenton only 208 lbs. of lead were used. To fill the remaining space between the sleeve and the main pipe, use was made of a hole in a lug cast on the upper part of each sleeve near the flange. These holes were 1½ ins. in diameter. In one of them a piece of wrought-iron pipe, 2½ ft. long, was inserted, and through it a 3 to 1 Portland cement grout was poured. The other hole served as a vent. As soon as the grout appeared at the vent this hole was filled by a screw plug. The pouring of the grout was then resumed until the pipe was filled to its full length of 2½ ft., thus giving a slight pressure on the grout within the sleeve for the purpose of filling every portion of the space. It is urged that to fill this space with molten lead is of little use, since the lead contracts so much on cooling as to leave a considerable space between the lead and the iron. The contraction of the cement grout, in comparison, is of little account. For a 30-in. sleeve the saving in lead amounts to 1,400 lbs., or at 6 cts. per lb., to $84. The cost of cement for such a sleeve would be insignificant in comparison.

The size of machine used at Trenton can be used to make 30 to 48-in. connections with corresponding or larger sizes of mains. Power-driven machines for smaller-sized taps are now being manufactured.

A GAS HOLDER BURNED at Hoboken, N. J., on the evening of March 28. The holder, which belonged to the Public Service Corporation, had a capacity of about 650,000 cu. ft.; it was connected with the distributing network supplying the west shore of the Hudson River from Jersey City north to Fort Lee, about 10 miles. It was completely filled at the time the fire started, and according to some statements it was overfilled, allowing gas to escape around the lower edge; this gas, becoming ignited in some manner, heated the tank and continued the discharge of gas until the fire wrecked the shell of the holder. The fire burned itself out after the structure was completely ruined.

SOME INTERESTING RESULTS OF TEST[S] OF EYE-BARS FOR THE QUEBEC BRIDG[E].

By Theodore Cooper, M. Am. Soc. [C.] E.†

In August, 1904, the manufacture of the [eye-]bars for the anchor arms of the Quebec Bridge was [under] way when the question arose as to what clear[ance] should be allowed between the pins and pin-holes. [The] forming the tension members were 15 ins. [wide], 1¼ to 2³/₁₆ ins. in thickness, and of length[s] [from] 58 ft. The pins, except in a few special c[ases] [were] ins. in diameter and from 8 to 10 ft. in [length]. The maximum joint has 58 bars on one pin.

After discussion, it was decided that [the] necessary for the purposes of erection should [be] than 1/32 nor more than 1/16-in., the latter [being] proportion given to ordinary bridge pins.

As the maximum working strains are [higher] than in usual practice, being about 21,000 lbs. per [sq. in.] in tension, the intensity and distribution of the [local] pressures from the pin to the eye of the bar became [important].

The writer, after a little consideration of [the] problem, realized that, while the local pressure must [be very] great, and the pin-holes must deform elliptically, [at least] elastically and probably permanently under [the proposed] working strains, the solution could only be [obtained] by experiment. He then devised a method of [measuring] the elongation of the bar from out to out of pin, while the bar was strained to varying amounts in the testing machines.

Four bars with different clearances were prepared and tested to 12,000, 16,000, 20,000, 24,000 and 28,000 lbs. per sq. in. While the result of these tests was not fully satisfactory, owing to the crudeness of the hurriedly made appliances, and the difficulty of reading the fine measurements in the limited space, they showed that the bars, from out to out of pins, began to elongate permanently at 12,000 lbs., and that the elongation increased with each increase of strain. The amount of the pin clearance did not modify the results especially.

Was this deformation, even at low strains, a peculiarity of this "make" of bars, or had it been observed in other tests? Looking up old records, the writer found in his abstract of tests made at the St. Louis Bridge in 1872 that of 58 eye-bars put to the proof test of 18,000 lbs. per sq. in., 5 showed a permanent elongation of the pin-holes of 1/16-in., 52 of them 1/32-in., and 1 of them 1/64-in. These were iron bars. In the Watertown "Tests of Metals" for 1883, there were found tests on 6 steel eye-bars, where the permanent elongation between pin centers at different strains is noted. They are abstracted in Table I.

TABLE I.—Bars, 6½ × 1 in.; Pins, 5 ins.; Excess, 40% at Sides; End Section, 86%.

	Stretch of Bar, out to out of Pin-Holes, in Ins.						
	10,000	20,000	25,000	30,000	35,000	40,000	
No. of bar.							Ultimate Strength.
4582	0.015	0.020	.....	.....	0.090	2.72	67,800
4583	0.010	0.020	0.025	0.040	0.060	2.63	64,000
4584	0.015	0.020	0.025	0.040	0.050	....	65,000
4585	0.020	0.025	0.030	0.045	0.070	....	65,950
4586	0.020	0.030	0.030	0.045	0.175	....	64,400
4587	0.010	0.015	0.025	0.030	0.060	....	68,200

It became evident, therefore, that the stretch of the eyes of eye-bars was not peculiar to the present "make" of bars, but had always occurred.

As it was important to push the construction of the work, it was decided to give the 12-in. pins 3/64-in. clearance, and, for the anchor arms then under construction, to add an extra allowance of 1/32-in. to the elastic elongation of each eye-bar for camber determinations; and should the further and fuller tests, then determined upon, show this to be too much or too little, the correction could be made in the cantilever arms.

The importance of the permanent stretch of the eyes, as affecting the structure in other directions, was not overlooked, but the data so far obtained were too few to furnish any definite conclusions.

Preparations were made for fuller tests, and, to eliminate the difficulties of the first method of measuring the stretch and also to get the action of each eye independently, the following method was adopted: Measure each bar from out to out of eyes, and calliper each eye longitudinally and transversely before putting it in the testing machine. Then, after straining the bar to 12,000, 16,000, 20,000, etc., lbs. per sq. in., remove it from the machine and repeat the measurements.

In preparing the bars for test, it was determined to get from bars already made such a selection as would give a wide range in "heat numbers," "thickness," "proportions of the head," and "pin clearances." Some of the bars were specially bored to change the proportions of the head and the pin clearances, and two bars with visible flaws in the head were selected.

A number of the bars were additionally tested by trying to maintain a constant strain for several hours, to determine the effect of time. There was an increase of stretch, but it is believed to be at least partially due to the difficulties of holding a constant pressure on the machine for a long time.

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*Abstract of a paper read before the American Society of Civil Engineers, and printed on p. 14 of the "Proceedings" for March 21, 1906.

†45 Broadway, New York City.

After a number of tests had been made, from 12,000 to 24,000 [illegible] it was found that the important data could be obtained with less frequent removals, and thus save much time and labor. Therefore, with the exception of some [illegible] tests, the records afterward were taken only at 20,000 and 24,000 lbs.

On plotting the results, using the stretch of the holes after [illegible] as the upper limit, it was found that the stretch of the eyes at various strains per square inch

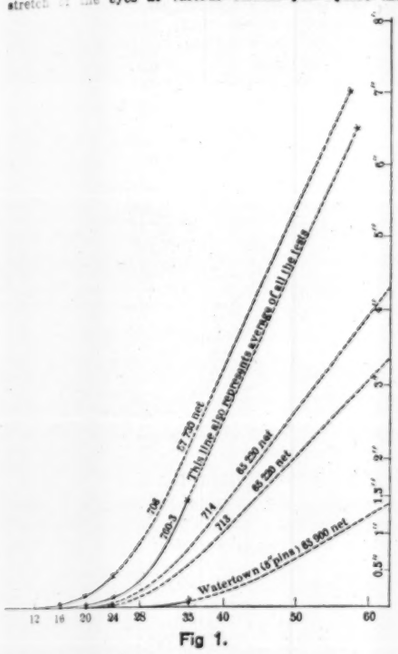


Fig 1.

followed a regular curve, differing for the different bars, but all having one general form, Fig. 1.

In order to save confusion by plotting each particular curve, the bars have been arranged in eight different classes, according to their stretch (covering both eyes). The average of each class is plotted in Fig. 2 on a larger scale than Fig. 1.

In addition to the previous observations, a number of the heads were scribed with fine lines, longitudinally and transversely, dividing the heads into spaces 2 ins. square. After the rupture of the bars, these lines were traced and plotted, for comparison with the plots of the lines on the original bars, to determine the relative flow of the metal in different parts of the head.

It would be difficult to reproduce these tracings on a small scale. In Fig. 3 the principal and important

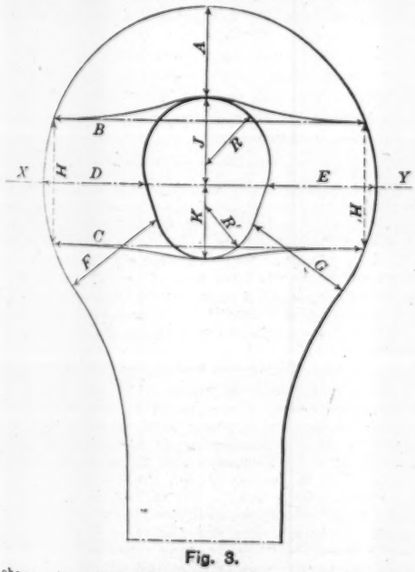


Fig. 3.

changes from the original dimensions are shown, and the values are given in Table II.

The line X Y is the transverse line through the center of the original pin-holes. The curved lines tangent to the elongated pin-hole are the forms taken by the straight lines tangent to the original hole before straining the bars. The upper part of the pin-hole is held to the form and diameter of the pin and has elongated more than the lower half. The diameter of the lower half has decreased by the transverse closing in of the material under the pull. At the top of the pin the metal of the head is decreased in depth by the compression. The transverse dimensions across the eye and neck are reduced by the flow of the metal under tension. It is interesting to note that with these proportioned heads the distances H and H′ on the outsides of the heads opposite the pins, have elongated very little or not at all, which would indicate that the periphery of the heads at these points had not been strained much more than the elastic strength of the metal, though the bar had been strained to rupture. It should be noted that in some of the 10 and 8-in. bars this distance on one side has been decreased, indicating a compressive distortion on one side. As, in two cases, it was as much as $\frac{1}{16}$ and $\frac{3}{64}$-in., it would not appear to be due to errors in measurement, the portion of the metal most severely taxed being that portion of the intrados of the eye lying between the horizontal and curved lines at the top of the pin.

CONSIDERATION OF THE RESULTS.

As far as relates to the original purpose of the first tests, viz., to determine the effect of the pin clearances, the tests give no definite answer. The different pin clearances vary from 0.031 to 0.084-in.

While, no doubt, the pin clearance has some influence on the stretch of the eyes, it is hidden in the far greater influence of other factors. The eyes would undoubtedly elongate permanently were the pins fitted perfectly tight.

The study of the present tests leads the writer to believe that a great stretch of the eyes before rupture, heretofore considered as showing a tough and tenacious material, is no more desirable than a tendency to buckle in front of the pin. The best proportions of head to resist the elongation of the eyes under the working strains cannot be decided by the present tests. It is thought probable that, for circular heads, 50% excess across the eye, thus making the end section 75% of the bar, would be a favorable proportion.

In a general examination of the tests it will be seen that the bars of the higher tensile strengths gave the better results.

Before the tests had gone very far, it was decided that the tensile strength should be advanced, the percentages of the heads increased, and the pin clearances for the bridge bars limited to $\frac{3}{64}$-in.

An inspection of Figs. 1 and 2 shows that each class of bars, after giving a steadily increasing stretch, up to a certain point for each class, then begins to yield more and more rapidly, the bars of the higher tensile strength, as a rule, and presumably the harder bars, resist this breaking down up to a higher point. The unequal pulling of the metal in different heads and in different parts of the same head, as shown in Table II. and Fig. 3, shows that the metal is not homogeneous, but is softer in some bars and in different parts of the same bar. It is probable that the breaking down of the metal in front of the pin unequally is a large factor in the problem.

It is undoubtedly a great mistake to seek a soft and ductile eye-bar by using either low tensile material or softening processes.

To get the best results, we must either use steel of a higher grade, or else stretch the eyes longitudinally, cold, before the final boring to exact length, or do both. The writer believes that, with proper appliances, eye-bars can be made, which will not stretch in the eyes within the maximum working strains, without greatly increasing their cost.

As the tests here recorded have extended over a year's time, and every effort has been made to have them fairly represent the bars as manufactured from time to time, it is believed that the actual bridge bars will be better than those tested, the pin clearances and proportions of the heads being better and the tensile strength somewhat higher.

These tests do not take any account of the elastic elongation of the eyes, which no doubt occurs, but would probably be small and constant for the different bars.

PRACTICAL CONSIDERATION AND APPLICATION OF THE RESULTS OF THE TESTS.

Upon the development of the fact that eye-bars were not perfectly elastic even at low working strains, and took an increasing permanent stretch with increasing loads, it became a grave question as to "How will a series of such bars pull together?"

If two or more bars with different curves of stretch are strained to a fixed amount on the same pins, the parallelism of which is assured, the total elongation, A C, in Fig. 4, would be equal, but the permanent elongations, B C, being different, the elastic elongations, A B, must have a like difference.

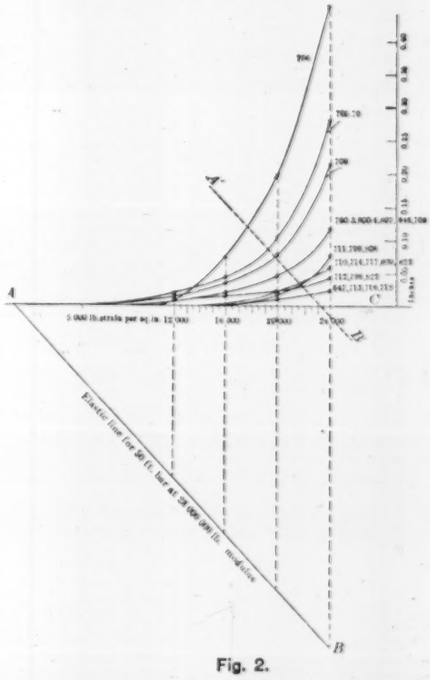


Fig. 2.

The elastic elongations, A B + A′ B′, corresponding to the total load, must be divided between the two bars proportionately to A B and A′ B′. The difference of strain on the two bars will depend upon the ratio of the difference of permanent stretches, B B′, to the average elastic elongation, A B + A′ B′ ÷ 2.

The permanent stretch, at any working strain, being independent of the length of the bar, while the elastic elongation is proportionate to the length of the bar, the difference of strain in two such bars will be less as the lengths of the bars are greater.

In Fig. 1 the line A B is the elastic line for a bar 50 ft. long. The vertical ordinates between A B and A C give the elastic elongations of a bar of this length for any strain per square inch. The vertical distances from

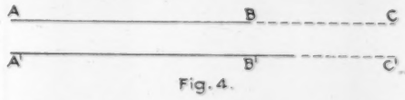


Fig. 4.

A C to the curve of any bar gives its permanent stretch for each strain. Any line, A′ B′, drawn through the curves of stretch of the several bars parallel to A B, will give, at the points of crossing, the strain on each bar for that condition of loading. The total elongations, being between two parallel lines, must be equal at these points.

For bars of other lengths, the elastic line must be changed to suit each particular length.

Although it is believed that the actual bridge bars are better than the bars tested, it will be assumed that the various bars shown in Fig. 2 cover the extremes and represent the variety of bars to be used.

By drawing any line, A′ B′, parallel to the elastic line for a bar 50 ft. long, and taking off the strain on each

TABLE II.

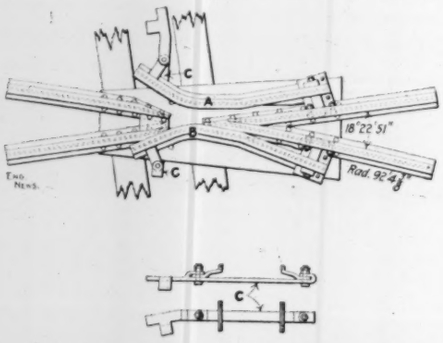
Bars.	Pins. Inches.	No. of Head.	Diam. of Head. Inches.	Deformation of Lines. (See Fig. 3.) In Sixty-fourths of an Inch. A	B	C	D	E	F	G	H	H′	J	K	R′ Inches.
15 ins.	12	708A	33	−16	−48	−88	−40	−40	−24	−80	+0+	+0+	+1	+	5
		710A	33.7	−16	−12	−32	− 8	−16	−16	−20	+0+	+0+	+1	+	5
		710B	33.4	−48	−64	−68	−48	−48	−64	−48	+0+	+0+	+2	+1	4
		713A	35	−32	− 8	−20	− 0+	− 0+	− 0+	− 0+	+0+	+0+	+1	+	5
		713B	34.8	− 7	−20	−24	−12	−12	−10	− 0+	+4	+4	+	+	5
		714A	34.9	−28	−32	−48	−24	−24	− 8	−16	0	0	+1	+	5
		714B	34.75	−28	−16	−44	−16	−16	− 0	−16	0	0	+1	+1	5
10 ins.	7	1A	22	−22	−19	−14	− 4	−44	− 0	−16	+3	−4	+1	+	3
		1B	22	−36	−64	−56	−14	−24	−18	− 3	+3	+3	+1	+	3
		1A	22	−28	−27	−45	−12	− 23	−18	− 3	0	0	+1	+	3
		1B	22	−28	−19	−14	−18	−19	− 9	− 8	+3	−5	+1	+	3
8 ins.	6	1A	18	−12	−18	−18	− 8	− 9	− 3	− 3	0	0	+1	+	2
		1B	18	−14	− 8	−16	−10	−10	−11	− 3	−1	+2	+1	+	3
		1A	18	−16	−20	−20	− 14	−10	− 5	− 5	+2	+2	+1	+	2
		1B	18	−18	−34	−27	−12	− 8	−13	− 2	−1	+6	+1	+	2

− Decrease. + Increase.

set of bars, we can readily get the average strain for all the bars and the limits of the variation, for example:

Bar.	No.	Strain.	Sum.
1	706	17,600	17,600
2	705-7	19,200	38,400
1	709	19,750	19,700
12	760, etc.	20,600	247,200
3	711 "	21,600	64,800
5	710 "	21,600	108,000
3	712 "	21,800	65,400
4	713 "	22,450	89,800
31	Average,	21,000	650,900

Which indicates that for bars of this kind, when pulled together on pins held parallel, for an average working strain of 21,000 lbs. per sq. in., the softest bar will have only 17,600 lbs. per sq. in., or about 84% of the average strain; and the hardest bar will have 22,450 lbs. per sq. in., or about 107% of the average—strains not disproportionate to the capabilities of the different kinds of bars.



Movable Wing-Rail Frog; Union Elevated Ry., Chicago.

Morden Frog & Crossing Works, Chicago, Builders.

For the longer bars, up to 58 ft.—50 ft. being the minimum length—the difference in strain will be still less.

For bars of short lengths, under high working strains, the difference in strain becomes very great, which renders the use of such bars very undesirable. It will be seen that, for much lower working strains and short bars, the bars will be subject to a like variation of strain, with long bars and the higher strains.

It is very sure, therefore, that, when using high working strains, as are required for structures of great magnitude, long bars only must be used, if this stretch of the eyes cannot be overcome.

CAMBER.

For the working strain of 21,000 lbs. per sq. in., it was found that a full set of bars of this kind would take a permanent elongation of about $\frac{1}{16}$-in., or $\frac{1}{32}$-in., for each eye, and this amount was provided for in all camber determinations. Further, it is thought that the probable error at the center of the channel span will not be more than 1½ ins. either way, an amount of no importance.

A CENTRIFUGAL PUMP WITH A NOVEL FORM OF RUNNER.

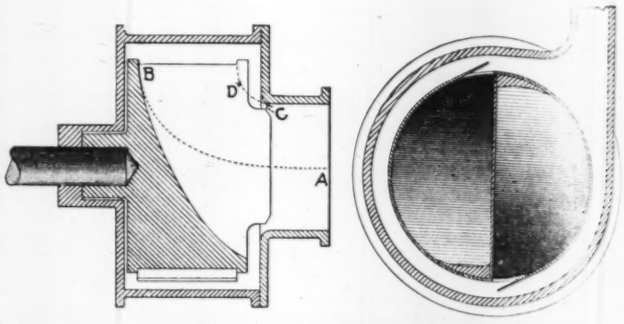
In most centrifugal pumps the runner is narrow (as measured on the axis of the shaft) and has a diameter considerably greater than that of the central inlet opening. In a new centrifugal pump invented by Mr. E. W. Brooks, and named after him, the runner is wide and driven at high speed. The runner is, in fact, a hollow piston, with impellers formed within it, and having two slots or openings in the shell.

It is claimed that in this design the curve representing the resultant of the thrust and the centrifugal force is kept within the pump. In the accompanying section, the line A B shows this curve for the water which enters at the center and strikes the relatively slow-speed portion of the runner. The line C D represents the same curve for the outer part of the column of water, which strikes the impelling blade at a greater distance from the axis of rotation, and is deflected more abruptly on account of the higher speed of this part of the blade or runner. These curves are parabolic, and coincide with the width of the slot B D in the runner. They are said to have been determined by numerous tests, and the pump is so designed as to avoid cutting the curves. It will be seen that the rear edge of each slot has a projecting lip, and these lips keep the outflowing columns of water from impinging against the annular body of water between the piston and casing, thus reducing the eddying effect to a minimum. They also aid to some extent in impelling the water towards the discharge opening in the casing. The pump is built by the Dayton Hydraulic Machinery Co., of Dayton, O.

MOVABLE WING-RAIL FROG IN AN INTERLOCKING PLANT.

Movable-point frogs are frequently used in track crossings of small angles or on sharp curves, and some railways have used for yard work a frog having a fixed point but movable wing rails. This latter has no spring, but is moved by the wheels and remains in whichever position it is thus set until another train or car shifts it over. The accompanying cut represents a special design of movable-wing frog in use at the sharp curve on the Union Elevated Ry. (elevated loop line) at Wabash Ave. and Van Buren St., Chicago. The curve has a radius of 92 ft. 4⅝ ins., and the angle of the frog is 18° 22 mins., 51 secs.

The rails forming the frog points are riveted to the base plate, and the two hinged wing rails A and B are attached by clamps to the bridle C. This is connected up to the interlocking plant, so that when the switch is set for either track the frog is thrown to give a practically continuous rail for that track. The width of throat is 2¼ ins. This frog was built by the Morden Frog & Crossing Co., of Chicago.



A NEW FORM OF CENTRIFUGAL PUMP.

Dayton Hydraulic Machinery Co., Dayton, O., Builders.

THE PHOTOGRAPHIC REPRODUCTION OF BLUE-PRINTS.

By W. L. Butcher,* Assoc. M. Am. Soc. C. E.

There is a growing tendency in engineering offices to invoke the aid of photography for the purpose of reducing large plans to convenient sizes, both for filing and for use in the field; it being generally possible to show on small reproductions all of the necessary details, which, under the customary conditions, require the use of large and cumbersome rolls or portfolios of plans. Photography is also of use for reducing plans of various scales to a uniform one for the purpose of making assembled drawings, the reduced prints being used directly under the tracing cloth.

For the above various applications the reductions could often be conveniently made from blue-prints. This operation, while to the uninitiated an apparently simple matter, is attended with certain difficulties. As an aid to the explanation of the difficulties and the method of overcoming them, a statement of certain elementary photographic principles may not be out of place.

Diagram Showing Relative Sensitiveness of Dry Plates to Light from Different Parts of the Spectrum.

The ordinary dry plates or films on the market are, when exposed to rays of light of different colors, affected in varying degree, depending upon the wave length of the light in question. This is plainly shown on the accompanying diagram by the line "A." It has been found, however, that the addition to the emulsion of a small quantity of certain dyes, notably Erythrosin, extends the sensitiveness of the plate into the green, yellow and orange region of the spectrum, as shown by the line "B."

A consideration of the above diagram will show that when it is attempted to photograph a blue-print, the blue of the background, to which the plate is very sensitive, impresses itself on the plate in only a slightly less degree than the white lines, with the result that the developed image of the lines stands out but faintly on a dark background, from which even passable prints can be taken only with great difficulty. Some success has been attained by changing the blue to green by chemical processes, but the whole soon fades, thus destroying the original.

The writer's method depends upon the well-known fact that the background absorbs all of the light coming to it but the blue, so that if we cut off the blue rays from the source of light it will be black. With ordinary dry plates we run across the difficulty that as the blue rays are near the upper end of the visible spectrum, forcing us to choose a color toward the red, we get into the region of chemically inactive rays. This obstacle is overcome by the use of so-called Orthochromatic or Isochromatic plates, which, as shown above, are sensitive to the yellow and orange rays.

The operation of taking a negative is best performed by covering a window facing the south with two or three thin sheets of orange-colored paper, in front of which the blue-print is set up and photographed in the ordinary way. Of course, a somewhat extended exposure is required, amounting in some cases to ten or fifteen minutes. Furthermore, it should not be expected that good reproductions can be obtained from poor prints any more than by ordinary methods, the best results being obtained when the original consists of clear white lines on a deep blue background.

*211 Lake View Ave., Cambridge, Mass.

THE LARGEST GASHOLDER IN THE WORLD will soon yield the place of honor to the six 15,000,000-cu.-ft. holders now being built for the Consolidated Gas Co., of New York City, at Astoria, L. I. These holders will be 300 ft. in diameter and when filled will be lifted to a height of 200 ft. The holders are of steel, resting in steel tanks 48½ ft. deep. The largest gasholder now in use has a capacity of 12,160,000 cu. ft., and is a part of the property of the South Metropolitan Gas Co., of London, England.

NEW RAILWAYS IN INDIA to the extent of about 3,500 miles are to be constructed by the government within the next three years, while surveys are being made for projects aggregating an additional length of 2,000 miles, to be undertaken after the completion of the former works by the end of 1900. The new mileage will include some long lines of 300 and 400 miles, of both 5 ft. 6 ins. and meter gage, but it will consist very largely of branch lines and feeders to existing trunk lines. About $50,000,000 are to be expended on the railways during the three years ending with 1900, of this amount $25,000,000 will be for construction and improvement work, and $15,000,000 for new motive power and rolling stock equipment. As much of this equipment is urgently needed, as well as material for building new and strengthening old bridges, and as the Indian works for such manufactures are few and of small capacity, a number of large orders are likely to be placed in Europe, and perhaps in this country.

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An announcement appeared in our issue of March 22 of the appointment, by President Roosevelt, of representatives from various national engineering societies to constitute a National Advisory Board on Fuels and Structural Materials. As our readers are aware, the Government has now under way a system of tests on a large scale, which are really an outgrowth of the Government testing laboratories established in connection with the St. Louis Exposition. The appointment of this Advisory Board, made up as it is of engineers and scientists of acknowledged preeminence in the profession, gives assurance that these tests will be carried out in a thoroughly impartial and reliable manner, so that their results can be safely used by engineers in writing specifications and dimensioning structures.

Particular attention is being directed to the tests of concrete and reinforced concrete, which are to be made not only with the aid of the National Advisory Board but with the cooperation also of the Joint Committee on Concrete and Reinforced Concrete, composed of similar committees of the American Society of Civil Engineers, the American Society for Testing Materials, the American Railway Engineering and Maintenance of Way Association and the Association of American Portland Cement Manufacturers.

This Joint Committee has already been at work for a year and a half and has made an attempt to obtain the data desired by the profession by collecting and comparing the results of tests made at various engineering school laboratories and by various manufacturers of reinforcement systems. We are informed, however, that many of these earlier tests have been found for one reason or other to be so inconclusive that a new and thorough system of tests under competent expert direction has seemed to the committee an absolute necessity to attain results which would command universal acceptance. The preliminary steps toward the conduct of this work in the Government testing laboratory above referred to have all been taken and an excellent working organization has been created. It now only remains for Congress to provide by adequate appropriation for the carrying out of the plans which the Joint Committee has approved. The appropriation asked for the current fiscal year is $100,000. In view of the enormous investments now being made in concrete construction of every sort, and the great demand for information that will make possible greater economy and reliability in its use, it would appear that Congress could hardly make an appropriation of the public funds which would be approved with greater unanimity or which would result in a larger measure of public benefit.

If professional honor and honesty are a valuable asset of the engineering profession—and who can doubt that they are?—the pertinent question arises where the young engineer is to attain the moral character on which such professional honor must be founded.

Elsewhere in this issue a teacher in a Western engineering school calls attention to the responsibility of engineering instructors in this particular. He holds it to be as much the duty of the engineering schools to see that their graduates go out morally fit to carry professional responsibilities as that they are mentally fit. The engineering graduate will make up his lack of professional knowledge in the school of experience; but if he has not adopted right moral standards during the years of character formation, he is not likely later on to acquire the ability to resist temptation.

There is, however, one qualification to be made to our contributor's suggestion that higher standards of honesty be maintained in college work and infractions be more severely punished. College standards and customs frequently become strangely perverted, and boys of excellent moral character are often led into courses of conduct that are really due to mistaken ideas of honor rather than intentional dishonesty.

The location of belt lines to carry through traffic around populous cities is a feature of railway development which is becoming more and more common on the trunk line railways. With the phenomenal congestion of freight traffic which has occurred at more or less frequent intervals during the past half dozen years, it has become clear to railway managers that the limit to traffic movement is chiefly set by the capacity of the terminals and yards; and when the yards of any large city along the line become congested, that congestion frequently blocks and delays trains passing through.

The Pennsylvania R. R. particularly has undertaken extensive works for the diversion of its through freight traffic around some of the larger cities along its main line. A recent notable example is the location of a four-track belt line around Baltimore, extending from Severn Station, 12 miles south of Baltimore, around the city several miles away from the built-up portion and meeting the main line of the Philadelphia, Wilmington & Baltimore R. R. again at Stemmer's Run. It is said that already there are nearly 300 through trains daily which can be sent over this line and not pass through Baltimore at all.

At Chicago the difficulties of getting freight from the West to the East through the city are well known, and there are already several belt lines by which freight is diverted around the city. The fact that Chicago is the dividing point between the Eastern and Western railway systems, however, makes the problem of passing freight around that city more difficult than elsewhere.

It is particularly noteworthy that this diversion of through traffic around populous centers is wholly an outgrowth of very recent experience with traffic congestion. The well-proved maxim of the railway locating engineer has long been to carry the line through every intermediate city possible in running between two terminals. This maxim still holds good; but the growth of cities and of traffic have made it clear that to develop the maximum traffic capacity of a great trunk line railway, the through traffic must be separated as far as possible from the local traffic by diverting it around these intermediate cities.

Various items are appearing in the newspapers concerning the proposed railway line from Russia to the United States via Arctic Siberia and Alaska, with a tunnel under Behring Strait. The promoter of the scheme is Baron Loicq de Lobel, of Paris, and a company known as the American Trans-Alaska-Siberian Ry. Co., has been formed, it is said, for the conduct of the enterprise. It is asking a concession from the Russian Government of a grant of alternate sections of land eight miles square on either side of the road, with mining rights thereto. The proposed route would branch from the Trans-Siberian Ry. somewhere near Kansk, and would probably follow the valley of the Lena River for a considerable distance. The total distance from Kansk to Behring Strait is roughly estimated at 3,000 miles; another thousand miles in Alaska would bring the road to Dawson, and another 800 miles would probably bring it to a junction with the Grand Trunk Pacific Ry., which it is safe to say will reach the Pacific coast at least as soon as the Alaska-Siberian Ry. is ready to furnish it with traffic.

Of course, no surveys of this proposed railway have ever been made, if we except a spectacular sledge trip of one of its promoters through the part of the Siberian territory which it is proposed to traverse. Enough is known, however, of the region through which the road would run to accurately describe it, for at least three-fourths of the distance, as a "howling wilderness," with an Arctic climate, peopled only by wandering tribes of natives with none of the needs or customs of civilization. An interesting sidelight on the region is furnished by current press dispatches, which state that a recent scarcity of food among these nomadic tribes has caused the starvation of a large proportion of the population, with accompanying cannibalism and suicide.

As for the crossing of Behring Strait, it appears to involve the driving of a submarine tunnel 18 miles in length beneath water with a maximum depth of 350 ft. On this basis, we should judge the promoters had better be content with a ferry transfer there, even if the through passengers between New York and Paris do have to submit to an occasional enforced stop-over of a few months while the Strait is blocked with icebergs.

To speak seriously, it is hardly to be supposed that the promoters of this enterprise have any real intention of actually building this 5,000-mile "wild-goose" railway; or, rather, have any serious idea that the public could be persuaded to subscribe the money for such a crazy scheme. What is probably intended is to secure a franchise from the Russian Government under which a short railway can be built to develop some of the rich placer grounds in the valley of the Lena River and secure the land and mineral rights which will make such exploitation possible without the present restrictions enforced by the Russian Government.

This may be an appropriate time and place to record the reappearance of that stale old story, to which we have before alluded, concerning the building of a ship canal in Russia between the Baltic and the Black Sea. The item before us avers that it is to be 1,000 miles long, is to cost $100,000,000, and is to be built without locks! Just how the framer of this item expects to have the Russian battleships ascend the rivers Dwina and Dnieper (which are to form part of the canal) and climb over the height of land dividing their headwaters, we cannot imagine; but if he has any patent scheme for accomplishing this, he ought to hasten to Washington and lay it before the Senate Committee which is wrestling with the Panama problem. If ship canals are to be had as cheap as $100,000 per mile, the United States will place an order for about 50 miles, on guarantees of prompt delivery.

REINFORCED CONCRETE FOR TRAINSHED ROOFS.

The use throughout of reinforced concrete for the roof work of the head-house forming a part of the new Atlanta Terminal Station, described elsewhere in this issue, raises the question why it might not have been used to advantage in roofing the adjacent trainshed. As built, the Atlanta trainshed has an arched steel roof 230 ft. wide, with a single row of columns at the center. To suggest even the possibility of replacing this lofty open structure with any form of roof capable of being built in reinforced concrete will very likely appeal to many as absurd. Is it so? We do not believe that it is, and for the purpose of

drawing out discussion we shall set forth briefly some of our reasons for this opinion.

The wide-arch train-shed roof so much used by railway engineers in the past is not an unqualified success; it is not even, we make bold to add, sound engineering. We do not here refer to the faults in detailing these structures in many instances in the past—such faults as were, for example, illustrated in the collapse at the Charing Cross Station, in England—but to the broader error which lies in a design that exceeds the structural necessities. Let us present the case briefly.

The primary structural necessity of a trainshed roof is to shelter waiting trains so that passengers entering and leaving them are protected to a reasonable degree from inclemencies of weather. A second structural necessity is that the design be such that the noxious gases given off by the locomotives are dissipated so rapidly that the air is always pleasant to breathe. It is eminently desirable, furthermore, that the design be such as to permit reasonable freedom in the adjustment and readjustment of tracks and platforms to meet needed changes in traffic conditions.

Now, the bold and commanding appearance of the wide-span trainshed roof makes it vastly impressive to the layman, and this gives it an advertising value that is of considerable importance. Despite all this, the wide-span roof fulfills the duty of a shelter no better than a simpler and cheaper form of roof can be made to do. Indeed, there are many who believe that inclosed trainsheds are altogether unnecessary, and that ample provisions for shelter are made by simply covering the station platforms, leaving openings above the tracks for the free escape of steam and other destructive gases from locomotive engines. Again, the immense space inclosed by a wide, lofty roof gives room for the locomotive gases to dissipate, and the air is kept pure without special provision for ventilation. This is a distinct structural merit, but one that is not impossible of attainment with less pretentious roof forms. No greater freedom from noxious gases is possible in any form of structure than is provided by umbrella platform roofs, while inclosed trainsheds with subdivided roofs can readily be kept free from gases with only ordinarily careful attention to ventilator construction. In respect to giving freedom for track and platform changes, the single-span roof is, of course, unrivaled; but such entire freedom from interior columns is not an imperative necessity. Were it so, we should have few subdivided trainsheds, while, as a matter of fact, there are scores of them in existence and new ones are all the time being built.

We believe the preceding is a fair statement of facts. Be this as it may, however, and be the advantages of wide-span roofs what they may, we must set against them the following conceded disadvantages: Corrosion by locomotive gases, to which all railway overhead structures of steel are subject, is of particular concern in these large arch roofs, both because the great height of the steelwork renders inspection and maintenance exceptionally difficult and because unchecked corrosion involves a risk corresponding in magnitude to the great size of the roof units. In a word, the initial cost of these great arch roofs is excessive; the corrosion is no less than in other steel roofs, while the potential risk due to corrosion is greater, and inspection and maintenance are so difficult and expensive that they are either neglected or form a constant burden of care. For example, it is only by the most particular and constant vigilance that leakage is controlled and the menace of falling glass is kept down.

In what has been said we have not cited suppositious possibilities, but actual experiences. In a paper recently read before the Manchester University Engineering Society, Mr. W. Noble Twelvetrees, reviewing the experience of English railways with single-span trainshed roofs, says:

> Indications are not wanting in the present day that the fashion for monumental roofs is distinctly on the wane so far as railway stations are concerned. In several of the most recent designs for such roofs small spans have been adopted, and it is probable that the tendency to reduce initial expenditure and the disadvantages of huge spans will finally lead to the practice of simply covering the station platforms.

We have no doubt that the statements quoted express truly the conditions in England, but be this as it may, they certainly express with truth and exactness the conditions in this country. Granting all this, what bearing has it on the use of reinforced concrete for trainshed roofs, it may be asked. The answer is, of course, that if the lofty single span roof is no longer an unquestioned requisite of trainshed construction, then we come down to roof forms that are without chance of doubt within the span limits of reinforced concrete.

The best proof of the accuracy of this conclusion is had in a review of the reinforced concrete roof-work now being done, and that has been done in the past. It is not fully realized even by those who have made it a practice to follow somewhat closely the records of building work in reinforced concrete to what lengths engineers have gone in bold and light roof design.

Flat slab and girder roofs of 50 and 60 ft. span are so common in recent reinforced concrete building work that they now pass unnoticed, while spans of greater length are not uncommon—in one instance called to mind the span length reaches 102 ft. Turning to peaked roofs, we have a good example in the waiting room roof of the Atlanta Terminal Station, illustrated in this issue. European works show numerous truss roofs of equal and less span, many of them carrying monitor ventilators and lights. While the truss spans actually built all fall considerably short of 100 ft., few European engineers regard this as being the limiting length. So high an authority as Mr. Considere believes that by using hooped reinforcement, truss spans exceeding 300 ft. are entirely practicable, and he now has under construction, if we are correctly informed, a truss bridge in France that has two spans of 318 ft. each. Arched roofs with tie rods have been constructed in Europe with spans up to 85 ft. Some of these roofs are remarkably light; there is, for example, a freight house roof at Basel, Switzerland, with a plain arch span of 16 m., about 52½ ft., in which the arch is only 10 c. m. (4 ins.) thick at the crown and 14 c. m. (5½ ins.) thick at the foot.

Subdivided trainshed roofs in steel seldom have spans between supports that exceed 100 ft.; in most cases these spans are from 50 to 60 ft. only. In a word, it would be possible to duplicate them in reinforced concrete girder, truss or arch forms without going beyond what has already been done successfully in numerous cases. Column construction in reinforced concrete has reached so advanced a state of efficiency that the question of supports for such roofs causes no concern. In a word, there are to-day no structural difficulties in the way of building trainsheds of all types, except possibly that represented by the wide arch roofs of a few great terminals, entirely of reinforced concrete.

Indeed, when we come to consider the work done with reinforced concrete in arch bridge construction, it does not appear so very rash to contemplate the duplication of one of our present day wide span steel arch trainshed roofs. The Chatellerault Bridge in France has a ribbed arch span of 50 m. (164 ft.) with a combined depth of rib and slab at the skewbacks of only 80 cm. (32 ins.), while the remarkable Wildegg, Switzerland, bridge has a plain arch span of 37.22 m. (122 ft.), with a crown thickness of 17 cm. (6.69 ins.) and a skewback thickness of 25 cm. (9.84 ins.) The matter of end supports is, of course, the serious problem in applying these and longer spans in roof construction; absolutely rigid foundations and unquestionable means for handling the arch thrust must be ensured.

Setting aside speculation, however, we have in trainshed roofs of the subdivided type an unquestionable opportunity for the use of reinforced concrete. The spans of such roofs as they are ordinarily built in steel are not beyond the span lengths that are possible with reinforced concrete trusses and arches. Light, ventilation and aesthetics can be obtained in reinforced concrete quite as readily as in steel construction. In addition, we have the enormous advantage that the reinforced concrete structure is absolutely free from depreciation and danger from corrosion, and is of the most fire-resisting character.

As a fitting termination of these remarks, we quote the closing paragraphs of the previously mentioned paper by Mr. Twelvetrees:

> In conclusion, the author desires to point out that however much the design of iron and steel roofs may be improved, the question of corrosion will always have to be faced. No form of paint or other protective coating has been discovered that will effectually shield metal from the chemical action taking place in the presence of oxygen, moisture and acid.
>
> Nevertheless, it is a well-known fact that Portland cement of good quality properly applied is an absolute preservative for iron and steel. This points clearly to the advantages to be derived from the employment of concrete-steel, especially in railway station roofs. The material in question has been used in the United States for the construction of roof principals in spans up to 100 ft., and in this country for arched beams up to 54 ft. span. Hence it is perfectly clear that railway station roofs, together with their supporting columns, could easily be built of reinforced concrete which, demonstrated by numerous examples of bridge construction, lends itself to light and elegant types of design, capable of enduring for centuries with practically no attention or expense in the way of maintenance.

LETTERS TO THE EDITOR

Another Form of Instrument for Trisecting an Angle.

Sir: I find in your issues of Jan. 4 and March 1, 1900, the description of two different straight-line instruments for trisecting an angle. I send you herewith the sketch of a very simple instrument based on a different principle. It can be made in a few minutes and used with as great accuracy as any others. I have used it with good results many years ago.

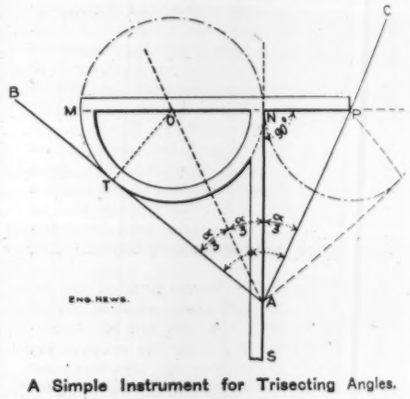
In the sketch, M N is the diameter of a circle, whose center is at O.

N P=O N=O T.

N S is tangent to the circle at N. Then the triangles O T A, O N A, P N A are equal, and

angle O A T=O A N=P A N=⅓ B A C.

The instrument may be made of pasteboard or simply may be drawn on a piece of tracing cloth or celluloid. To trisect an angle B A C, slide the instrument over



A Simple Instrument for Trisecting Angles.

the angle, keeping the line N S on the apex A of the angle and the point B always on A C, until the side A B is tangent to the circle. Then the points O and N are on the trisecting lines.

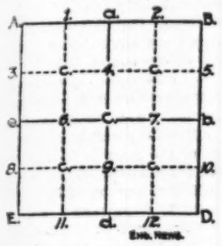
It is obvious that if another circle with center P and radius P N be added, we will have an instrument capable of dividing an angle into four as well as into three parts.

Emilio Thivolle,
Engineer, Obras del Palacio Legislativo Federal.
421 Calle de Tamaulipas, Mexico City, Mexico,
March 21, 1900.

Names for Subdivisional Corners of a Section.

Sir: Mr. Gillett asks for the proper names which should be used to designate the subdivisional corners of a section of land. Usage is not uniform among good surveyors in this respect and who shall decide what is proper and what is not? For myself, I prefer to use the names suggested by the statute providing for the survey and subdivision of sections. Taking the corners in their order and following the law we have first the section corners, concerning which I do not know of any difference in usage. Then the law provides for dividing the section into halves and quarters. So far as the law is concerned, any corner of a quarter-section, except that at the center of the section, may with equal propriety be called either a half-section or a quarter-section corner. I prefer to drop the half-section as a name for a corner. The law then drops the section and provides how the quarter-section shall be divided into half-quarters. The corners thus fixed I should call half-quarter (or eighth) corners. The law next provides for dividing

the half-quarter sections into quarter-quarter sections. The corners thus fixed I should call quarter-quarter (or sixteenth) corners. Thus following the statute and using Mr. Gillett's diagram, A B D and E are section corners.



a b d e and C are quarter-section corners. 1 2 6 7 11 and 12 are half-quarter corners and 3 5 8 10 c c c c are quarter-quarter corners.

F. Hodgman.

Climax, Mich., March 31, 1906.

Sir: In your issue of March 29 a correspondent asks about the proper names of government corners. Prior to 1800 no provision had been made for the subdivision of the sections, but by an act of Congress of May 10 of that year (Statutes, Vol. II., page 73) directions were given for the subdivision of the sections into half sections by lines running north and south through the sections. The corners established under this act were designated as half section corners. However, the subdivisions under the act of 1800 are confined to a small portion of territory along the Muskingum River in southeastern Ohio. The act of 1800 was superseded by an act of Feb. 11, 1805 (Statutes, Vol. II., page 313) providing for the subdivision of the sections into quarter sections by lines running north and south as before and also by lines running east and west. The corners of these subdivisions were called quarter corners. An act of April 24, 1820 (Statutes, Vol. III., page 566) provided for a further subdivision of the quarter section into half quarter sections by lines running north and south through the quarter sections. And the corners of these subdivisions were called half-quarter corners. And finally, April 5, 1832 (Statutes, Vol. IV., page 503) a supplementary act was passed directing the subdivision of the land into quarter-quarters by a further east and west line. The corners of these smallest subdivisions under the act were referred to as quarter-quarter corners.

Now, referring to Mr. Gillett's figure and notation, from these acts it will be seen that the corners a b C d e are quarter corners, as first surmised, also corners 1 to 12 and c c c c are quarter-quarter corners.

Yours truly, H. M. Stout.

Worcester Polytechnic Institute, Worcester, Mass., March 31, 1906.

Concerning the Movement of Vessels in Narrow Channels.

Sir: In your editorial of March 22, commenting upon Mr. Clemens Herschel's letter on "A Tidal Lock in a Sea-Level Canal," I notice the following sentence:

"The narrower the channel, the greater the liability that a vessel stemming the current will swerve from her course and strike the banks on either side."

The argument would have been much stronger if you had used the words "moving with" instead of "stemming."

Most river men know that a rudder is useless going down-stream unless the boat is moving at a greater velocity than the current.

A vessel in the canal, going with a current of 5 miles per hour, in order to be steered, would have to move down stream at a dangerous speed. If Mr. Herschel can get the vessels down safely there should be very little trouble moving in the opposite direction.

E. H. Beckler,
M. Am. Soc. C. E.

1838 Aldine Ave., Chicago, Ill., March 31, 1906.

[It is undoubtedly true that a vessel moving with a current must move faster than the current in order to steer at all; but it is also true that a vessel moving in a narrow channel, whether against a current or in still water at higher speed, will tend to veer to one bank or the other, and this tendency is the greater the higher the speed.

As a practical illustration of this, reference may be made to a paper on the Corinth Canal by Monsieur E. Quellenec, published in Appendix D to the Report of the Board of Consulting Engineers for the Panama Canal. M. Quellenec says that the Corinth Canal is 69 ft. wide at the bottom in the central rock cut and 81 ft. wide at the water surface, the depth being 26¼ ft. The area of the wet cross-section is 1,960 sq. ft. Among the largest vessels which have passed through this canal is the steamer "Lusitania," 320 ft. long, 42½ ft. beam and 19.68 ft. draft. The ratio of her cross-section to the water cross-section of the canal is as 1 to 2.69. M. Quellenec says:

When such a steamer is steered well, it can pass through the canal without much difficulty, but if it is not under good control, it inevitably strikes the side walls repeatedly during the transit.

It will be easily perceived, on a little thought, why a vessel moving with some speed through a narrow channel constantly tends to veer toward one bank or the other. As the vessel moves along the water is piled up at either side of the bow and for some distance back. If from any cause the vessel's head swerves slightly to the right, the mass of water on the left between the vessel's hull and the bank acts like a wedge to push the vessel's bow still farther over, while at the same time a freer passage is offered to water flowing past the bow on the right, and there is consequently less resistance on that side to the lateral swing of the bow than when the vessel was on a central course. Any engineer who has tried to pole a rowboat or canoe up a rapid knows how quickly the bow will swing around if it is not kept square against the current.—Ed.]

Depth of Thread of Mean Stream Velocities.

Sir: In an article by Mr. F. W. Hanna in the Engineering News of Jan. 11 he very ably shows the theoretical demonstration of the fact that the thread of mean velocity lies at some point between .5 and .7 of the total depth of the stream, below the surface, or to be more accurate, between .58 d. and .67 d., when the thread of maximum velocity lies between the surface and one-third of the total depth.

If the premise that the curve of velocity is "parabolic" is correct the theory advanced must be correct, but as a matter of fact does not correspond very closely with the result obtained in careful practice. In the majority of streams the thread of mean velocity seldom occurs at a depth less than .61 of the total, and often is found as deep as .75 to .77 of the total depth. A case is occasionally found where two threads of mean velocity occur in the same curve, although seldom in an open stream. It is evident from the theory that in any case where the thread of mean velocity occurs at a point less than .58 d., the major axis of the curve must lie above the surface of the water, a condition which very rarely occurs, probably never, at well chosen stations.

Apropos to the foregoing, would say that the practice of some engineers in making measurements by the "point" system, to take the velocity at .5 d. and then apply a correction to obtain the mean velocity for that position, to determine the mean velocity by direct observation for any other point.

As a matter of fact, the determination of the mean velocity for the whole cross-section, which is the data sought, cannot be found by the "point" method alone, within what should be the limit of error admissible in many cases, because in order to so determine it must be known at what depth the thread of maximum velocity occurs, in order to apply the theory within the limits of accuracy that ought to prevail, and to determine this depth by merely looking at the stream is as impossible as to determine the depth at which the thread of mean velocity occurs by the same method. It would be quite as well to "guesstimate" the latter, and so eliminate one chance of error.

The title of Mr. Hanna's article would indicate the belief that the theory set forth is only applicable to rivers or natural streams, while in practice it has been found that the flow in artificial waterways conforms with the theory, as to character of the curve, although the percentage of depth at which the mean velocity is found is considerably increased, quite as near as is the case of a natural stream.

The selection of a gaging point in any stream should be the result of extended investigation and study of that particular stream, and the methods used in the deductions should be the result of study of the particular point selected. The point selected for gaging should have a flow due solely to an even slope or grade of the stream and should be as far removed as possible from the influence of an increased or decreased slope; either above or below the point selected, as either of the conditions will throw the curve of velocity away from the normal.

Figs. 1 and 2 show data very carefully taken, with the most approved instruments, on two types of streams, one natural, and the other artificial, with conditions radically different. These two examples are selected, not as extreme cases of their kind, but as nearly representative as possible.

Fig. 1 shows the results of measurements made on a natural stream, the bed of which is composed of clean wash gravel, fairly even, and of stones varying from 1 to 6 ins. in size. The figure shows the cross-section of the stream, three vertical velocity curves, and the curve of horizontal mean velocities.

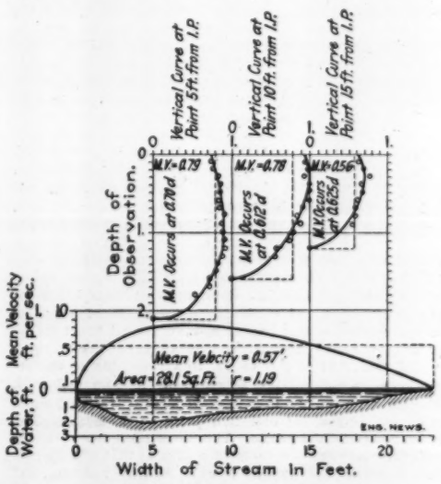

Vertical Curve at Point 5 ft. from I.P.
Vertical Curve at Point 10 ft. from I.P.
Vertical Curve at Point 15 ft. from I.P.
M.V.=0.79
M.V.=0.78
M.V.=0.56
M.V. Occurs at 0.78 d
M.V. Occurs at 0.612 d
M.V. Occurs at 0.625 d
Depth of Observation.
Mean Velocity ft. per sec.
Mean Velocity = 0.57'
Area = 28.1 Sq. Ft. "r" = 1.19
Depth of Water ft.
ENG. NEWS.
Width of Stream in Feet.

Fig. 1. Natural Stream.

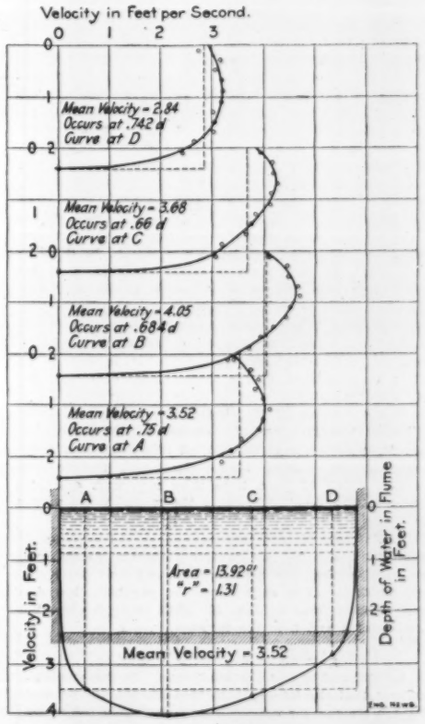


Fig. 2. Artificial Stream.

FIGS. 1 AND 2. DIAGRAMS ILLUSTRATING MEAN VELOCITIES IN NATURAL AND IN ARTIFICIAL STREAMS.

seems ill advised inasmuch as the true mean seldom, if ever, occurs at that proportion of the depth, and that the further we digress from the actual conditions the greater the liability of error.

Another point that might well be considered is the fact that probably no two curves, taken at different parts of the same cross-section, will show exactly the same characteristics, the result being that a vertical curve taken at any one point does not under this system give us any criterion from which to select the depth at which

According to the theory advanced by Mr. Hanna, the mean velocity for the curve taken at 5 ft. from the I. P. (initial point), would occur considerably below .8 d., while the curve shows it to occur at .7 d., while the other two curves show results very close to the theory.

Fig. 2 gives the cross-section and deductions from data obtained in a flume of regular section, with fairly smooth water-worn sides and bottom, flume quite old, but well preserved and quite clean.

The alinement is straight below, and for about 450 ft.

above the measuring station, at which point there is a slight bend (see effect in curve of horizontal mean velocity).

The slope of the water surface through this flume, determined by careful levels, is 0.0027.

From the data given here and in Fig. 2, a determination of the value of "n," for use in Kutter's formula, gives 0.025. The slope of the water surface for the case of Fig. 1 is 0.0005 and the value of "n," as deduced, is 0.056.

Yours truly,

Charles L. Swain, Civil and Hydraulic Engineer.

Freewater, Ore., March 7, 1906.

[The foregoing letter having been submitted to Mr. Hanna, he has replied as follows.—Ed.]

Sir: In connection with the foregoing letter the writer wishes to supplement with additional data his contribution on this subject to the Engineering News of Jan. 11, 1906, where points in it have been brought into question.

The assumption that the rates of flow of water in a vertical plane parallel to the current is sensibly a parabola, the axis of which is horizontal, has been quite well established by experimenters both in Europe and America. It is conceded, however, that the relation is an approximation, but it is held that the error involved is for usual cases negligible. In the season of 1904 the writer gathered information to confirm this theory. Data from eleven different rivers in four different states in the Mississippi Valley were obtained by actual visitation for 30 vertical velocity curves on open streams in addition to others on frozen streams. These curves were all carefully plotted and the mean velocity determined for each by averaging the ordinates. Each curve was then assumed to be a parabola and its mean velocity, or ordinate, determined on this basis by taking it equal to one-sixth of the sum of the top, bottom, and four times the mid-depth velocity. A comparison of these results for open streams showed an average error of only *one-fifth of one per cent.*, while the error in no case exceeded the usual error in velocity determination. (See St. Louis Engineering Congress Paper No. 29, Trans. Am. Soc. C. E., Vol. LIV., Part B, 1905.)

Relative to the depth of the mean thread of velocity and its application to the determination of mean thread of velocity by the single point method, the writer computed by the Method of Least Squares the mean position and the mean coefficient for 0.6 depth for 801 curves obtained by the hydrographers of the United States Geological Survey from streams of all characters from various parts of the United States. These curves gave for the depth of the mean position 0.5995 ± 0.00091 of the total depth, with a probable error of ± 0.0228 for a single observation with the weight unity. The theory of probabilities applied to the data showed that 131 observations out of 10,000 should be expected to be found below 0.7 of the depth and 51 out of 10,000 should be expected to be found above 0.5 of the depth. The average coefficient to be applied to 0.6-depth observations proved for this series to be 0.997 ± 0.0023, while the error for a single observation of the weight unity was only ± 0.064. (See Trans. Am. Soc. C. E., Vol. LIV., Part B, 1905.)

The claims for the single point method and consequently the 0.6-depth method are based on its rapidity, generality, and reasonable accuracy. It is not to be used to the exclusion of the more accurate vertical velocity curve method.

As to the position of the thread of maximum velocity, the writer has just recently examined 682 curves obtained from all parts of the United States by the hydrographers of the United States Geological Survey and finds that 13.8% of them have their maximum ordinates below one-third depth. Of these the majority are only a trifle below.

In cases where streams are very deep and in cases of flumes and canals of comparatively narrow widths with respect to depths, the maximum thread lies below the one-third limit. For such cases the parabolic law discussed in your issue of Jan. 11, 1906, is applicable, but the value of a and b in the formula,

$$y = ad \quad d\sqrt{\tfrac{1}{3}(a^2 + b^2)},$$

must be changed to suit the conditions. In these cases it is evident that the 0.6-depth method should not be used. For these reasons my article in the issue referred to was given the title under which it was printed ("Depth of Thread of Mean Velocity in Rivers").

F. W. Hanna,

Engineer, U. S. Reclamation Service.

1333 Park Road, Washington, D. C.

The Economy of Water Transportation.

Sir: A little space is hereby asked in which to make a different application of some of the facts presented by Prof. Frank Haigh Dixon, of Dartmouth College, in his address before the St. Louis Railway Club, printed in Engineering News of March 22, 1906.

The Professor reaches the conclusion that water transportation on the Great Lakes is cheaper than rail transportation on paralleling lines, but destroys the value of the conclusion by veiling an undetermined element in the following statement:

> But of far greater importance is the fact commonly overlooked by those who compare these rival means of transportation, that the right of way is furnished to the lake vessel free of charge. This does not mean that it has cost nothing to build or that nothing has to be spent in maintenance. It does mean that the people have paid through taxation for a 20-ft. channel from Duluth to Buffalo, and for the construction of a canal at the "Soo," and it means that the people are spending every year large amounts of money for deepening and straightening the channel and for keeping it properly patrolled and inspected. The people have also constructed adequate harbor and dock facilities to expedite the loading and unloading of vessels. It is certainly a fair question whether the railroads could not have made a more remarkable record than they have done in the matter of rate reductions if the government had built their roadways, kept them in repair and provided them with their station and terminal facilities. But I shall refer to this point again in the discussion of canals.

The Professor states that the lake rate on 28,974,660,408 ton-miles of freight passing annually through the "Soo" is 0.92 of one mill. It is impracticable now to obtain the total freight transported on the Lakes but, for comparison, that passing through the "Soo" only will be taken as the total freight movement, although it is thought that such freight movement is nearly twice that passing the "Soo" and the saving to be deduced later should in reality be nearly double.

The Professor also gives the average rate per ton mile on the paralleling railroads as 5.24 mills. Multiplying the difference between these rates by the total freight transported by water gives $125,170,532.96 as the direct annual saving to the people on account of water transportation on the Lakes, on that freight passing the "Soo" Canal, omitting the remainder, assuming, of course, that the same freight movement would exist without the water transportation. The greater portion of this freight is iron ore, and if the absence of water transportation prevented its movement, it would be difficult to place a figure high enough to measure the consequent loss. Applying the difference between the Lake and rail transportation rates to the distance that the iron ore is hauled on the Lakes, we find that the present freight cost on the Lake Superior ores (utilized now on the Lake shores and in the Pittsburg district) would be increased by about $3.25 per ton if rail haul were substituted. Whether this would prevent bringing the Lake Superior ores to the coke of the Pittsburg district, either in such district or on the Lakes, is a question for the Professor. The above combination of ore and coke, made possible by the cheap water transportation on the Lakes, is thought to be the most evident reason for the recent remarkable growth of the iron industry in this country.

The Interstate Commerce Commission has in its reports divided the railroads of the country into several groups. An examination of such report for 1904 will show that the lowest freight rates are in Group III., that most affected by Lake transportation. The data given by the Commission show that the prevailing rate in this group is 1.38 mills per ton-mile less than the average of the adjoining groups. Multiplying this difference by the total freight transported in this group gives $47,274,956.94 as an approximate measure of the indirect annual saving to the people on account of the water competition of the Lake route. It is thought that the saving in freight rates on the north and south movement of freight by rail in Group VI., and the saving in east and west rail freight rates in Groups II. and VI. will compensate for the inclusion in the above computation of certain commodities moved in Group III., the freight rates of which are not directly affected by Lake competition.

An examination of the list of the entire appropriations for improving the Great Lake system, including the construction of all of the canals, harbors, channels, etc., together with their maintenance from 1823 to date, shows a total of $81,263,493.72. Quite a small expenditure for the construction and maintenance from 1823 of a system of transportation that causes now an annual direct saving of at least $125,170,532.96, and an annual indirect saving of $47,274,956.94 to the people, to say nothing of the remarkable manufacturing development in iron and steel directly traceable to this improvement. It would seem that no well-founded objection could be made to similar investments by the people. This investment has certainly paid for itself and accumulated a surplus that will operate and maintain the system forever, and in addition will furnish enough money to improve completely all the other important waterway systems of the country.

As to the other rivers, the Professor seems to have forgotten that he was talking of unimproved rivers. A line of transportation has a very limited use, under present conditions, unless it is permanent for a definite portion of the year at least, and one would look for little, if any, increase of traffic on such a line; in fact, a decrease would be expected as other more reliable systems of transportation were built. There is transported annually on the Monongahela River about 12,000,000 tons of freight. This river is slackwatered from one end to the other. It has a low-water discharge of only about 170 cu. ft. per second. There would hardly be transported on it, if unimproved, 500,000 tons annually. None of the manufacturing plants in Pittsburg would [illegible] on it for coal. Comparison, therefore, of water [illegible] transportation, based on transportation on [illegible] rivers, is misleading and of no value.

The Professor states that a rate of 0.5 mill per [illegible] is shown as possible on the Ohio and Missis[illegible] tems, on which rivers one large-sized towboat [illegible] as much as do six of the largest Lake steamers [illegible] ever, this freight can only move during freshets [illegible] amount of it that can wait for such movement [illegible] reached a maximum. An examination of the [illegible] charges on the railroads paralleling this water [illegible] shows the average of the same to be 7.33 mills [illegible] mile. If the water conditions under which the Professor found a half mill per ton mile rate practicable were made permanent by improvement, why should not a repetition of the results found on the Great Lakes be indicated? Thus making the Ohio and Mississippi system reduce the cost of export to such an extent as to make such system as important in determining our ability to sell abroad as the Great Lakes have been in bringing together cheaply the raw materials essential to manufacture.

If such projects as that on the Great Lakes, taken in connection with a similar project to reach tidewater with iron and steel products, if the same be practicable, were paid for by the localities interested, it is thought that after the Panama Canal is constructed the tax assessor or collector of benefits would not only have to take in the entire United States, but would have to cross the Pacific and enter the Chinese Empire in order to reach all of the interested parties.

Railroads thrive best where cheap water transportation for the bulky raw products exists. Such transportation often makes manufacture financially possible where it would otherwise be impossible, and that means an increase in manufactured articles that must be distributed all over the country by railroads. The full possibilities of a country can only be brought about by a proper development of all systems of transportation.

As to canals, the Professor should confine his comparison to the railroad facilities of 50 years ago, otherwise the conclusions are unfair and of no value. With 35,000,000 tons of iron ore and coal, commodities especially suited to water transportation, to be transported annually between the Great Lakes and the Pittsburg district, one should be loath to conclude, in view of the present water rates on the Lakes and the Ohio River, that a canal connecting the localities in question would be unremunerative. The Erie Canal, completed 40 years ago, with its animal traction, with a capacity determined by conditions 40 years ago, is still important in determining the freight rates from New York to the Lakes, as shown by examination of the Interstate Commerce Commission's annual reports. The new barge canal should undoubtedly be a freight regulator and carrier, also a potent factor in forcing many products of the Great Lakes country via New York on their route abroad and prevent the same following the St. Lawrence route.

Wm. L. Sibert,

M. Am. Soc. C. E., Corps of Engineers, U. S. Army.

U. S. Engineer Office, Pittsburg, Pa., April 2, 1906.

[In the interests of accuracy, it should perhaps be said that in the comparison between the Lake rates and the rail rates, the rail rate taken should not be the *average* rail rate, which includes the high class merchandise freight, but the lower rail rate on the bulk freight, such as coal, ore, lumber, grain, etc., which constitutes the great bulk of the freight moved by water.

The suggestion that the Lake routes are responsible for the lower average freight rate in Group III. (comprising the states of Ohio, Indiana and southern Michigan) as compared with the rest of the country, does not seem to us well founded. This section contains a larger proportion of trunk line traffic—long distance haul of through freight or heavy trains than any other section of the country. Included in this group's traffic also is the enormous tonnage of coal and iron ore carried between Lake Erie ports and the manufacturing centers of Ohio and Western Pennsylvania. We are very strongly of the opinion, therefore, that it is the character of the traffic and not the Lake route competition that is the chief cause of the lower average rail rate in Group III.

There is no doubt at all, however, and we are sure that Prof. Dixon would be the last to deny, that the Great Lakes have been and are a transportation route of enormous value to the nation and well worth all the money that has been invested on their improvement. To what extent the results attained there can be accepted as a guide to justify expenditure on the Ohio and Mississippi navigation is another story.—Ed.]

Notes and Queries.

In the map of the Canadian Northern Ry., published in our last week's issue, a draftsman's error was overlooked in the symbols on the map of the system. The heavy broken lines which were referred to as the Canadian Pacific lines are really extensions of the Canadian Northern system projected or under construction.

J. ... Paris, Ill., asks for "information for making the distinction between wet and dry excavation in foundations for piers and bridge abutments."

We should say that it would depend on the purpose for which the distinction was made. If the specification allowed a different rate of payment per cubic yard to the contractor for dry excavation and wet excavation, we should say that a proper division would be the plane of ordinary low water of the stream to be crossed. Material above this plane can ordinarily be taken out in the dry with little expense to the contractor for cofferdams or pumping, while below it more expensive methods must be used.

THE COLLAPSE OF A MASONRY TOWER ON THE WESTERN DEPARTMENTAL BLOCK, PARLIAMENT BUILDINGS, OTTAWA, ONT.

By J. A. M.

A remarkable and exceedingly expensive accident occurred on Parliament Hill, Ottawa, Ont., on April 5. The tower on the new wing of the Western Departmental Block collapsed at 11.45 o'clock, and is now a heap of ruins, a source of mortification to the government and of very serious loss to someone. As if by a miracle, no one was hurt, although there were four men working on the tower roof when the collapse occurred. This new wing was built from east to west from one of the older wings of the building to another. Its style of architecture was exactly the same as that of the older part of the building, and the outer surface of the wall, like that of the rest of the building, was of Nepean stone, trimmed with drab sandstone. At the northwestern corner of the wing was a square tower rising to the height of about 100 ft. and capped by a copper roof of pyramidal form.

Work on the new wing was commenced last spring, was continued throughout the summer and winter, and was about completed. At the time of the collapse four men were working on the copper roof. Suddenly two blocks of stone slipped and fell with a crash to the ground. This was sufficient warning to the men. They swung themselves by ropes and with great difficulty managed to reach an open window in the adjoining old part of the building. While they were in the act of swinging to the window, two-thirds of the face of the tower and the entire top crumbled away like the face of a pile of sand and tumbled with a crash in a heap on the ground below—a mass of cut stone, crumbled cement, twisted iron beams and crumpled sheets of copper. George Goodwin was the contractor. The collapse ruins about one-fourth of the new wing.

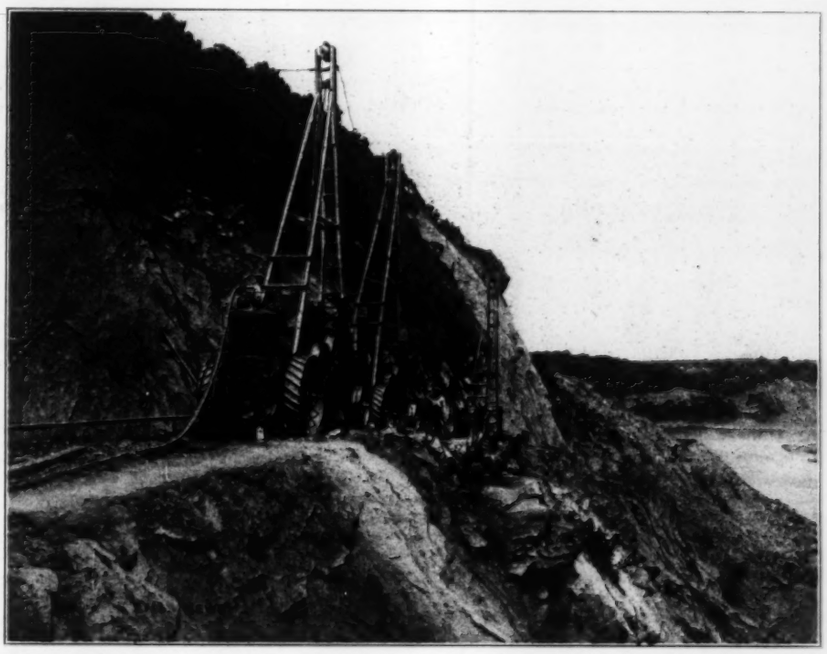
The collapse of the tower was discussed on Friday in the House of Commons. The opposition members were very severe on the government, and charged the Public Works Department with gross negligence. It seems there was no regular outside inspector of the work. The government architect, Mr. Taylor, who drew the plans, was the nominal inspector of the work, but, it seems, did very little actual inspection. The collapse was at first attributed to carrying the work on in the winter, but the parliamentary inquiry into the matter shows that the masonry was anything but of a substantial character, there being no bond stones in the entire wall. A veneer brick lining was spaced some inches from the outside wall, and there was no bond of any kind between the brick and the stone and no cement or grouting in the fill. The mortar used was sampled at Friday's sitting of the House. Several members, having secured samples of the mortar from the crumbled walls, had them on their desks, and on exhibiting them to the House showed the mortar to be nothing more than sand. If any cement or lime had been mixed with the sand, there was no bond between them. Possibly this might be from working in the frosty weather.

Mr. Armstrong, M. P., East Lambton, an experienced builder, said he had made an examination of the collapsed building, and it showed that large sections of the center wall were filled with cinders. With such a binding in the center of the wall it seemed impossible that it could stand. Mr. Elsen (East Middlesex) said that after making a thorough examination of the ruins "he was surprised it stood so long as it did. There were no tie-stone in the wall." Mr. Clements (West Kent), having examined the ruins, said that the "mortar appeared to be nothing but sand." Mr. Chisholm (East Huron), a practical builder, gave it as his opinion that "there wasn't a farmer in Ontario who would accept such a job for a cow-house." Mr. Wright, of Muskoka, characterized the job as a most disgraceful piece of work. Mr. Avery, Member for Frontenac, said he could not see that there was a single binding stone in the whole building.

THE WORK OF WELL-DRILLING MACHINES ON THE PENNSYLVANIA R. R. LOW-GRADE FREIGHT LINE.

By W. R. Hulbert.*

In the article on the low-grade freight line work of the Pennsylvania R. R. in Engineering News of Dec. 28, 1905, mention was made of the use of well-drilling machines in preparing for the enormous blasts employed in making the heavy side-hill rock cuts between Columbia and Safe Harbor, Pa. The present article enlarges upon the work done by these machines. There were 42 machines in use, and the results attained were so remarkable that the writer believes they warrant special mention.



VIEW SHOWING WELL DRILLING MACHINES AT WORK ON SIDE HILL ROCK CUT OF PENNSYLVANIA R R., COLUMBIA TO SAFE HARBOR, PA.

It will be remembered by those who read the previous article that the plans involved a double-track line at a height above the Susquehanna River which would avoid all difficulty from high water; and its object was to remove the congestion of freight traffic on the main line as well as to reduce the heavy freight hauls which marked this section of the road. Probably the most difficult conditions were met on a section about nine miles in length beginning on the north, near Columbia, Pa., and reaching to Modic Fords upon the south. Along this stretch the hills jut into the river with abrupt headlands of solid rock several hundred feet high, and in many cases almost perpendicular.

The work here consisted of a continuous cut in solid rock, and the nearly vertical hillside made necessary the removal of vast quantities of rock with tremendous charges of powder before the necessary width could be secured at grade. This section is especially interesting and noteworthy, in that practically all the rock was removed by heavy blasts, the holes for which were drilled, as previously stated, by portable well-drilling machines operated by compressed air supplied from a central compressed air power plant. The contractor for this work was H. S. Kerbaugh, Inc., of Philadelphia, Pa., to whom the writer is greatly indebted for much of the data contained in this article.

Before describing the operation of well-drilling machines in connection with this contract, however, it might be well to state briefly the reasons which led to the selection of these machines for such important work. The above-named company had previously undertaken the construction of the Enola Yards for the Pennsylvania R. R. Co. They had 300 to 400 laborers drilling holes by hand, using churn drills and drilling to a depth of from 20 to 30 ft. The material drilled was shale, and could not be drilled by rock drills. At that time they had ten steam shovels, and contemplated adding that many more and working them day and night. The large increase in labor expense and the prospect that even an increase in the laborers would not keep the material loosened up in order that the shovels might dig uninterruptedly, forced them to adopt some better method of drilling. The cutting averaged 75 ft. deep, and it was therefore necessary, with churn drills, to make three lifts, requiring switchbacks and grades of 2% to get the material from the shovels to the fills. Well drills were adopted, and the cuts were made at grade, doing away with switchbacks and the 2% grades. The machines adopted had a drilling capacity of 250 to 400 ft. for 4½ to 6-in. holes, were fitted with 5 to 6-HP. reversing engines, and were manufactured by the Star Drilling Machine Co., of Akron, O. With 17 of these drills, single shifted, it was not only possible to keep 22 steam shovels working, but it was possible to keep holes drilled ahead. On the Enola Yard work all the well drills were steam-actuated, and a drill averaged 48 ft. of hole drilled per ten-hour shift. In some cases the drills made 80 ft. per ten hours, and in others less than 20 ft., this latter being due to caving in of the material, and it was sometimes due to the presence of limestone, flint or quartz in the last 15 ft. of the deep drilling.

After such a practical demonstration as this of the advantages to be obtained by the use of well-

*1 Hudson St., New York, N. Y.

drilling machines, it was natural that this company should adopt them in connection with the work at Safe Harbor, although it was an entirely different proposition from the Enola work. The ground to be drilled was hard rock of a gneiss mica-schist formation, with a small percentage of lime. This rock varied in hardness and the seams were at varying angles to the perpendicular, causing the drills to deflect and adding greatly to the difficulties. In crossing these seams and in straightening up the holes X-bits were used. The first 10 to 40 ft. in some places required casing, but in other places the holes started with the solid rock. The holes were 5⅝ ins. in diameter all the way down, and ranged in depth from 100 to 130 ft. The average drilling was 19 ft. 6 ins. per ten-hour shift, but the rate varied greatly, according to the location. On the west end of the work the rate was 60 ft. in ten hours, while at Mann's Run, where the holes were from 75 to 128 ft. deep, the rate was 11 ft. per day. At Star Rock 100-ft. holes averaged 14 ft. per ten hours. At Buzzard Rock, where holes were from 100 to 130 ft. deep, the average was 9 ft. per ten hours. From the Buzzard Rock to Brenner's Hollow, in 9,000 ft. of solid rock drilling, the holes averaged from 60 ft. to 130 ft. in depth, the rate of drilling being 9 ft. per ten-hour shift. From Brenner's Hollow to Safe Harbor Viaduct the drilling was from 80 ft. to 130 ft. deep, the average rate being 20 ft. per ten hours. The drills on the Safe Harbor work for the first 60 days were steam-actuated, and after that time were driven by compressed air, the size of the contract making it advisable to operate, as far as possible, all machines from a central power-plant, thus affecting considerable saving over the cost of operating numerous temporary boilers scattered throughout the course of the work.

The method of excavation has been that of drilling a number of very deep vertical holes along the inside of the desired cut, and a series of "snake" holes of a suitable depth on a level with the bottom of the vertical holes. These holes were "sprung" by charges of dynamite, then loaded with blasting powder and the entire series discharged at once by an electric current. Enormous charges were used and great quantities of rock dislodged. In many instances the major part of the mass was thrown into the river and required no handling; the last rock remaining was loaded in cars by chain shovels and run back over a light railroad to suitable dumping places, but fills were remarkably infrequent.

In carrying out this work the drilling machines were properly located and a branch pipe from the air main connected by a length of hose to the boiler, which thus served as a secondary receiver. No changes were made necessary in the machine itself by the use of compressed air in place of steam for the motive power, the machines working equally well on either. It was found, however, that they did not work effectively with less than 80 lbs. pressure. When steam-driven, they required one driller and two helpers; when air-driven, one driller and one helper.

Owing to the difficult positions in which these drills were placed, four men were required for every two drills to carry the bits to the blacksmith shop. In some places horses were used to drag the bits to the shops, while on one section it was necessary to use a horse and rope and pulley to hoist the bits to a road 125 ft. above the drilling stage to get them to a shop.

All the work in connection with this contract was side-hill work. It was therefore necessary, in order to place the well drills on the face of the cliffs, to make roads 10 ft. wide by hand labor, using in some places rock drills, drilling holes 10 to 30 ft. in depth. The drills were then propelled along these roads, drilling holes to the required depth. In some cases drills were erected at right angles to these roads, in order that a machine could drill holes in projecting points.

The question may arise in the minds of some readers as to how it could be economical to use machines which had to have a special roadway constructed for them along the sides of the cliffs. The answer to this is that the element of economy did not enter into the actual drilling. It was found in the greater efficiency in blasting, more rock being displaced by blasting well-drilled holes, drilled below grade, than by successive lifts of from 25 to 30 ft., using rock drills to drill the holes. Rock drill holes were drilled very rapidly, but were less efficient when blasted, each bench having to be cleaned off by hand labor except the final one at grade, which was cleaned off by using a steam shovel. The well-drilled holes, once drilled below grade, did such work so well that whatever material was left on the bench could be removed by steam shovels doing away entirely with hand labor.

The horizontal, or "snake," holes were drilled by standard rock drills, about 250 of these machines having been used on the work. The holes drilled averaged in depth up to a maximum of 35 ft. The deepest holes were 4½ ins. in diameter at the top and diminished to 1⅝ ins. at the bottom. As the rock varied considerably in character, the average being of a hard rather above the ordinary, the service was not easy on the machines, and the average of each drill was from 40 to 60 ft. of hole per day, including the necessary delays due to changing wheels and moving positions.

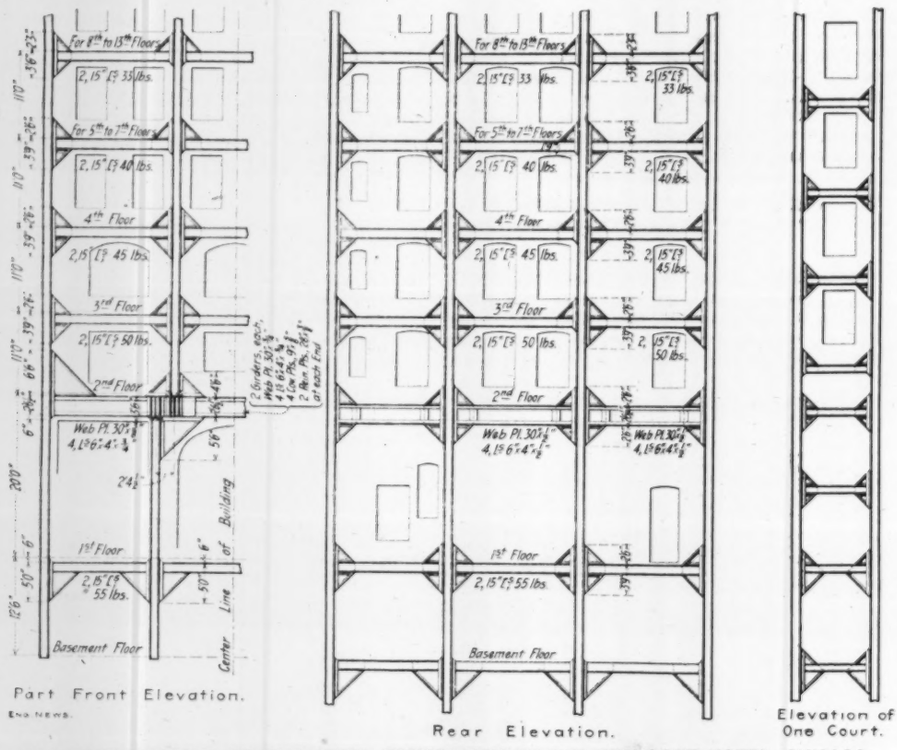


FIG. 1. ELEVATIONS OF THE STEEL FRAMEWORK OF THE BREVOORT HOTEL, CHICAGO, SHOWING THE GUSSET PLATE CONNECTIONS FOR WIND BRACING.
Purdy & Henderson, Chicago, Engineers.

WIND BRACING IN THE BREVOORT HOTEL BUILDING, CHICAGO.

In all tall buildings of steel structural construction the design of the wind bracing is important in order to ensure stiffness and rigidity in the steel frame. This is of special importance in narrow buildings located in exposed positions, and the accompanying illustrations represent the method employed in the new Brevoort Hotel, Chicago. This building has 13 stories and is about 165 ft. high from the sidewalk to the cornice. It has a frontage of only about 50 ft. on Madison St., but extends north 170 ft., presenting a large exposed surface to the winds from Lake Michigan. The building is rectangular, but with two light courts 10 ft. deep on the east side, and the wind bracing is introduced in the front and rear wall framing and in the ends of the courts. It will be seen that the plan adopted is the use of gusset plates at the connections between the columns and girders, and while this arrangement has been used before, the size of the gussets is in this case greater than usual, giving a high degree of rigidity. At certain points the gussets have had to be omitted on account of the location of windows, etc., but this is compensated for by additional strength above and below.

The general structural framework design comprises three lines of columns and three longitudinal rows of 12-in. I-beams, between which are

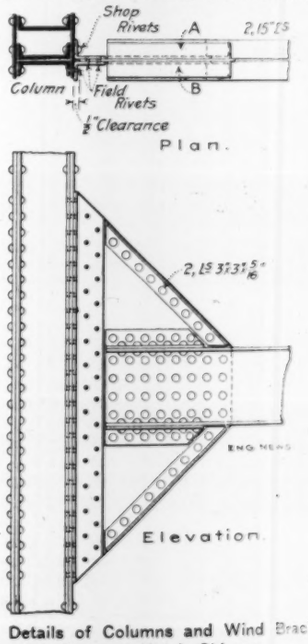


Fig. 2. Details of Columns and Wind Bracing in the Brevoort Hotel, Chicago.

10-in. and 12-in. I-beams forming the floor beams. In the end walls, pairs of 15-in. steel channels are used instead of I-beams, with 30-in. plate girders at the second floor. Special attention is called to the arrangement of columns in the front wall, as shown in the elevation, Fig. 1. Owing to the broad entrance planned by the architect, the two

inner lines of columns are 19 ft. 7 ins., c. to c., as far as the second floor, above which they are 14 ft. 10 ins., c. to c. At the second floor, therefore, the upper columns rest upon heavy reinforced plate girders, as shown. The elevation also shows the wind bracing in the front and rear walls and in one of the court walls.

The details of the column, beam and gusset construction are shown in Fig. 2. The columns are all box section, built up of three channels and two plates; they are made in two-story lengths, with splices midway between the floors. The web of the wall girder (built up of two 15-in. channels) is in line with the heavy outer side of the column formed by the two channels. This not only gives a direct and continuous line of thrust through the beams and columns, but also requires a less thickness of wall to enclose the steel work than if the webs of the beams coincided with the center line of the columns. The gussets are of ½-in. plate up to the seventh floor, and of ⅝-in. plate above this. They fit between the steel channels and are reinforced at the edges by angles 3 × 3 ins. The attachment to the columns is effected by a pair of heavy angles riveted to the plate and to the column, as shown, and the plate does not come in direct contact with the column. The object of this is to ensure accuracy in erection. If the plates were made to fit the columns, and some of them should be sheared a little short of full length, the columns would be drawn inward at these connections, and there would be difficulty in fitting a beam of proper length in the next panel above. With the arrangement here employed, the plate is of such length as to give ½-in. clearance between it and the column, the thrust being transmitted through the angle attachments. In construction, the beams were riveted up with the gussets in place, and the columns had the inside angle connection, A, riveted up at the shop. When the beam was erected in place, the outer angle connection B was put on and riveted to the plate and column. If both the angles A and B had been riveted to the column at the shop, any bending or distortion of these or of the gusset in shipment would then make it difficult to slip the gusset plate into place between them. It was therefore decided that the extra field riveting would be well warranted by the facility and rapidity of erection thus obtained.

The steel framework of this building was designed by Purdy & Henderson, of Chicago, and we are indebted to them for plans and other information. It was built by the American Bridge Co. and erected by the Wm. Grace Co., of Chicago, who were the general contractors. The architects were Egan & Prindeville, of Chicago.

MALLET COMPOUND DUPLEX LOCOMOTIVES FOR THE GUAYAQUIL & QUITO RAILWAY.

The Guayaquil & Quito Railway, in Ecuador, is one of the noted mountain railways of the world. Having a total length of only 110 miles it rises, in about 103 miles, from sea level at Guayaquil to a maximum elevation of 10,648 ft. A description of this interesting railway was published in our issue of Aug. 11, 1904.

The motive power equipment for operating a railway of this character is an important matter, and has consisted principally of 45-ton mogul locomotives and 50-ton geared locomotives. With these engines the train loads are about 80 tons ascending and 250 tons descending. In order to increase the train loads, it was decided to introduce more powerful locomotives, but the numerous and extremely sharp curves made it essential that the length of rigid wheelbase of the mogul (2-6-0) engines should not be exceeded. To meet these conditions the Mallet duplex system was adopted, and two 57-ton engines of this type have been built by the Baldwin Locomotive Works. These engines are of the 0-6-6-0 type, having two groups of driving wheels; the rear group has the axles mounted in the main frames and is driven by the high-pressure cylinders; the front group has the axles mounted in a swiveling truck frame and is driven by the low-pressure cylinders. The general design is (on a reduced scale) very much the same as in the immense 167-ton pusher engine for the Baltimore & Ohio Ry., described and illustrated in our issue of June 30, 1904. A similar engine of 53 tons weight, built by the Baldwin Locomotive Works for the American Railway Co.'s meter-gage line in Porto Rico is shown in the accompanying cut. The two locomotives for the Guayaquil & Quito Ry. are for freight and mixed service, and burn soft coal. The dimensions of these are given below in our standard form:

Dimensions of Mallet Compound Duplex Locomotive (Type 0-6-6-0); Guayaquil & Quito Railway.

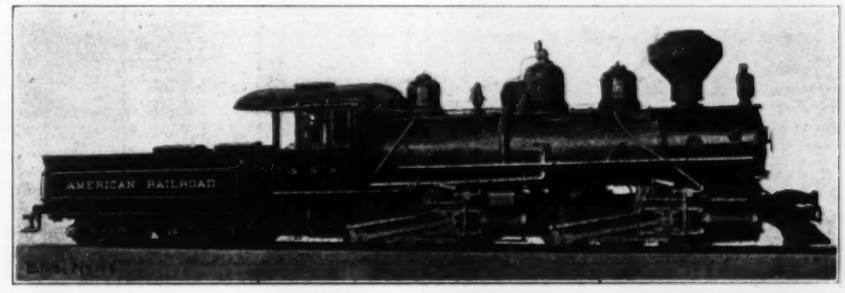
RUNNING GEAR:	
Driving wheels (12), diameter	3 ft. 1 in.
Tender wheels (8), diameter	2 ft. 2 ins.
Driving wheel centers	Cast iron
Tender wheels	Chilled plate
Driving-wheel tires secured	By shrinkage and shoulder
Journals, driving axles	6 × 7 ins.
WHEELBASE—Driving (each group)	6 ft. 10 ins.
Total engine	20 ft. 4 ins.
Tender	13 ft. 2 ins.
Engine and tender	42 ft. 7¼ ins.
WEIGHT IN WORKING ORDER:	
On driving wheels (and total)	114,100 lbs.
Does counterbalance conform to M. M. Assoc. rules?	No; 66% of reciprocating parts balanced.
Weight of piston and rod:	
h. p.	200 lbs.
l. p.	240 lbs.
Weight of crosshead	185 lbs.
Weight of main rod	220 lbs.
Weight of side rods	230 lbs.
CYLINDERS—Number	Four
Diameter and stroke of h. p.	12½ × 20 ins.
Diameter and stroke of l. p.	19 × 20 ins.
Ratio of area of h. p. to l. p. piston	1 to 2.31
Cubic contents of all cylinders	9.4 cu. ft.
Crosshead and guides:	Alligator crosshead; two-bar guides
Main connecting rod, length c. to c.	6 ft. 7 ins.
Side rods	Strap ends.

HEATING SURFACE AND GRATE AREA:	
Heating surface, tubes (exterior area)	1,251 sq. ft.
Heating surface, firebox	106 sq. ft.
Heating surface, total	1,357 sq. ft.
Grate area	18 sq. ft.
Ratio of total heating surface to grate area	75.4 to 1
Ratio of exterior tube area to firebx heat. sur.	11.8 to 1
Total heat. surf. to 1 cu. ft. cyl. vol.*	144.30 sq. ft.
Firebox heat. surf. to 1 cu. ft. cyl. vol.*	11.27 sq. ft.
Tube heat. surf. to 1 cu. ft. cyl. vol.*	133.09 sq. ft.
Grate area to 1 cu. ft. of cylinder volume*	1.90 sq. ft.
MISCELLANEOUS:	
Exhaust nozzle, double; diameter	3¼, 4 and 4¼ ins.
Exhaust nozzle, distance below center line of boiler	2 ins.
Smokestack, diameter at top and base	1 ft. 3 ins.
Smokestack, height	4 ft. 2 ins.
Smokestack, height, rail to top	12 ft. 8 ins.
Capacity of tender tank	13,500 gallons
Brake fittings	American, equalized on all drivers
Tractive force per lb. of effective pressure on two h.p. pistons	0.7†
Total tractive force, working compound	22,406 lbs.
Total adhesive tractive power at ¼ of weight on driving wheels	28,525 lbs.
Ratio of tractive force to weight on driving wheels	1 to 5.078

*All four cylinders considered.
†132 × 245 × 0.7 = tractive power.

ENGLISH THREE-CYLINDER COMPOUND LOCOMOTIVES.

In the editorial on three-cylinder compound locomotives in our issue of March 8 reference was made to the introduction of engines of this type by the Midland Ry., of England, and ten of these engines have recently been turned out by the railway company's shops at Derby. They were designed by Mr. R. M. Deeley, Locomotive Superintendent, and are of the eight-wheel or 4-4-0 class, with the usual English six-wheel tender.



MALLET COMPOUND DUPLEX LOCOMOTIVE FOR THE AMERICAN RAILWAY CO., PORTO RICO (METER GAGE).

Baldwin Locomotive Works, Philadelphia, Pa., Builders.

VALVE GEAR—Type	Walschaert.
Ports, steam h.p., 1⅛×10 ins.; l.p., 1⅝×16 ins.	
Ports, exhaust h.p., 2½×10 ins.; l.p., 3 ×16 ins.	
Bridges, width h.p., 1 in.; l.p., 1⅜ ins.	
Slide valves, max travel h.p., 5 ins.; l.p., 5½ ins.	
Slide valves, ins. lap (neg.) h.p., ⅛-in.; l.p., ¼-in.	
Slide valves, outside lap h.p., ⅞-in.; l.p., ¾-in.	
Slide valves, lead (constant) h.p., ⅛-in.; l.p., ¼-in.	
Slide valves, type	Balanced
Eccentrics, throw; forward, 8½ ins.; back	8 ins.
BOILER—Type	Straight top.
Barrel, diam. inside smallest ring	4 ft. 4⅞ ins.
Dome, diameter inside	2 ft. 3½ ins.
Barrel plates	9/16-in.
Smokebox tube plate	½-in.
Horizontal seams:	Butt jointed, with double covering strips
Circumferential seams	Double riveted
Rivets, diameter	⅞-in. and 1 in.
Height from rail to center line	6 ft. 2½ ins.
Smokebox, length including extension	5 ft. 6¼ ins.
Does smokebox arrangement conform to M. M. Assoc. rules?	No; Builder's standard
Spark arresting device:	Deflecting plates and netting of 3½ × 3½ ins. mesh
Injectors, two	Hancock
Working steam pressure	200 lbs.
FIREBOX—Type	Narrow; Radial-stay
Length inside	7 ft. 5 13/16 ins.
Width inside	3 ft. 3¼ ins.
Depth at front	4 ft. 3 ins.
Depth at back	4 ft. 1 in.
Thickness, side plates	⅜-in.
Back plate	5/16-in.
Thickness crown plate	⅜-in.
Tube plate	½-in.
Crown stays	Radial
Grate bars	Rocking, with drop
Fire-brick arch	Supported on studs
Stay bolts, Solid, with end tell-tale holes 1¼ ins. deep	
Stay bolts, diameter	¾-in.
Pitch, not over	4 ins.
Water spaces, width at front	3¼ ins.
Water spaces, width at back and sides	2½ ins.
TUBES—Iron; No.	155
Thickness, No. 12 W. G., pitch	2¾ ins. c. to c.
Diameter, outside	2 ins.
Length over tube plates	13 ft. 6 ins.
Total area of tube openings	2.59 sq. ft.

The cylinders are all in line at the smokebox (with the single high-pressure cylinder between the frames), and are all connected to the front driving axle. The principal features are described as follows in "The Engineer," of London:

The high-pressure cylinder communicates its power to a crank on the driving axle, and the low-pressure cylinders their power to crank pins on the wheels of the same axle. The outside cranks are at right angles to each other, and the high-pressure crank bisects the obtuse angle between them. The middle cylinder takes its steam from the boiler at 220 lbs. pressure, and this steam is exhausted directly to the chest common to the low-pressure cylinders. The steam regulator (or throttle) is of the gridiron type, provided with the usual main and jockey valves. There are three ports in the valve face of the throttle head, two of which communicate with the main steam pipe, and the third with an auxiliary pipe connected to the steam chest of the two low-pressure cylinders. When the throttle is closed a port through the main valve is superimposed on the port leading into the low-pressure auxiliary pipe, and this port and the by-pass port to the main steam pipe are closed by the jockey valve. As the throttle lever is moved from the shut position, the jockey valve gradually uncovers the ports through the main valve, and high-pressure steam is simultaneously admitted to the main steam pipe and to the low-pressure auxiliary pipe. The area of the passage through the throttle by which steam can pass to the low-pressure chests is maximum when the main valve is on the point of moving; further movement of the handle causes the main valve gradually to close this opening, and to increase the opening for the passage of steam from the boiler into the main steam pipe. When the handle is moved about 30° from the shut position, the admission of high-pressure steam to the low-pressure cylinders is entirely cut off, and the engine commences to work entirely as a compound. Still further movement of the handle opens wider the port for admitting steam to the main steam pipe.

To prevent unnecessary back pressure on the high-pressure piston, which occurs at starting in some positions of the engine, non-return valves are arranged on the back and front of the cylinders to allow of steam passing from the low-pressure steam chests into either end of the high-pressure cylinders. These valves only open when the pressure on the one side or the other of the high-pressure piston is lower than the pressure in the low-pressure steam chest.

The inside cylinder is placed slightly higher than the others, and has an inclination of 1 in 13; the outside cylinders have an inclination of 1 in 40. The high-pressure cylinder has a 10-in. piston valve beneath it, this being inclined upward 1 in 16. The low-pressure cylinders have slide valves, placed vertically between them and the high-pressure cylinder. Each valve has its own valve gear of the Stephenson link type, and all the valve gears are operated simultaneously from one reversing shaft by a screw reversing gear. The spring rigging has no equalizers, except on the truck. The main driving axle has coiled springs beneath the boxes, while the rear driving axle has semi-elliptic springs, also beneath the boxes. The truck is of the swing-center type, with inverted semi-elliptic springs suspended from the equalizers. The firebox has a steeply sloping grate and a long firebrick arch, while over the fire door is a long deflector. The smokebox is large for English practice, being 3 ft. 9 ins. long inside, and there is an entire absence of deflectors, draft pipes, etc. In the boilers of large English locomotives the smokestack is often extended down into the smokebox,

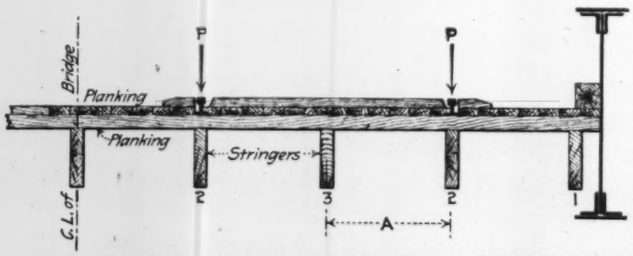


FIG. 1. TRANSVERSE SECTION OF FLOOR OF OLD HIGHWAY BRIDGE CARRYING ELECTRIC RAILWAY TRACKS.

but in this case there is no such extension, although the 5-in. exhaust nozzle is about 4 ins. below the center line of the boiler. The principal dimensions of these interesting engines are as follows:

Driving wheels (4)	7 ft. 0 ins.
Truck wheels (4)	3 ft. 6½ ins.
Tender wheels (6)	4 ft. 3 ins.
Journals, driving axles	8¾ × 9 ins. and 8 × 9 ins.
Wheelbase, driving	9 ft. 6 ins.
Wheelbase, truck	6 ft. 6 ins.
Wheelbase, engine	24 ft. 3 ins.
Wheelbase, tender	13 ft. 9 ins.
Wheelbase, engine and tender	48 ft. 3¼ ins.
Length over buffers	57 ft. 2 ins.
Weight on drivers	87,584 lbs.
Weight on truck	46,368 lbs.
Weight of engine	133,952 lbs.
Weight of tender (with 4 tons of coal)	96,152 lbs.
Cylinders, HP. (1)	19 × 26 ins.
Cylinders, l. p. (2)	21 × 28 ins.
Cylinders, c. to c.	6 ft. 3 ins.
Boiler, straight top, diameter	4 ft. 8 ins.
Boiler, rail to center line	8 ft. 2 ins.
Smokebox, length	3 ft. 9 ins.
Working steam pressure	220 lbs.
Firebox, Belpaire	8 ft. 6 ins. × 3 ft. 3 ins.
Tubes, copper, No.	216
Tubes, diameter, outside, 1⅞ ins; at smokebox end	2 ins.
Tubes, length between tube plates	12 ft. 3¾ ins.
Heating surface, tubes	1,305.5 sq. ft.
Heating surface, firebox	152.8 sq. ft.
Heating surface, total	1,458.3 sq. ft.
Grate area	28.4 sq. ft.
Smokestack, diameter, at base, 1 ft. 2 ins.; top	1 ft. 4 ins.
Smokestack, height above smokebox	1 ft. 11½ ins.
Smokestack, height of top above rail	13 ft. 3 ins.
Coal in tender	15,680 lbs.
Water in tender tank	4,200 U. S. gallons

THE LARGEST RIVER STEAMBOAT IN THE WORLD, the "Hendrik Hudson," was launched March 31, at the T. S. Marvel Shipbuilding Co.'s Yard, Newburgh, N. Y. The boat is approximately 390 ft. long, has a depth of 14 ft. 4 ins. and a draft of 8 ft. The breadth of hull (molded at deck) is 43 ft., with a breadth over guards (molded) of 82 ft. It has seven steel bulkheads, which practically eliminates all danger of sinking. The 6,000-HP. engines are of the incline type and will drive the 29-ft paddles at 40 r. p. m., giving the boat a speed of 23 to 25 mi. per hr. The new boat will have accommodations for 5,000 passengers and will be placed, next August, on the Albany-New York run by the Hudson River Day Line.

THE DISTRIBUTION OF LOADS ON STRINGERS OF HIGHWAY BRIDGES CARRYING ELECTRIC CARS.

By F. P. McKibben.* M. Am. Soc. C. E.

In many highway bridges which carry a street railway track the rails are laid directly upon a layer of planking, which in turn rests upon the track stringers, as shown in Fig. 1. This is a common method of supporting the rails on old bridges originally designed to carry ordinary highway traffic only, over which street railway tracks were subsequently laid. If the floor planking is laid transversely, it will act as a series of transverse beams, and will thereby transfer part of the rail load to stringers not immediately under the rail, and correspondingly reduce the load on the rail stringers. The distribution of the wheel-loads over the floor stringers of such a bridge is the subject of the following study:

Given:

P, the load on each rail, assumed at the center of the panel.
L, the panel length.
A, the distance center to center of stringers.
I, moment of inertia of the cross-section of the planking over which the loads P are distributed.
I_1, moment of inertia of each of the stringers.
E, modulus of elasticity of wood.

Required:

F_1, F_2, F_3, the amounts of load borne by stringers 1, 2, 3, respectively.

We have the three unknown quantities, F_1, F_2, F_3, and must therefore have three independent equations. These are deduced as follows:

$$2\,F_1 + 2\,F_2 + F_3 = 2\,P \qquad (1)$$

A second equation may be obtained by equating the difference between the deflections of the points 1 and 2 of the planking and the difference between the deflections of the same points of stringers 1 and 2. The third equation may be obtained by equating the difference between the deflections of the points 2 and 3 of the planking and the difference between the deflections of the same points of stringers 2 and 3.

The effect of the upper layers of planking will be neglected. The effect of the lower layer will be assumed to be shown in Fig. 2. Taking the lower layer of planking to be a beam with free ends at stringer 1, it will be sufficient, because of symmetry about 3, to consider only the section 3-1, represented by a cantilever beam fixed at 3 and loaded at 2 (by P and F_2) and at 1 (by F_1). Then the following expressions hold:

Deflection of point 2, with reference to point 3,

Downward, due to load $(P-F_2)$ at point 2, $= \dfrac{(P-F_2)\,A^3}{3\,E\,I}$

Upward, due to load F_1 at point 1, $= \dfrac{5\,F_1\,A^3}{6\,E\,I}$

Resultant, downward, $d_{23} = \dfrac{A^3}{6\,E\,I}(2\,P - 2\,F_2 - 5\,F_1)$

*Assistant Professor of Civil Engineering, Massachusetts Institute of Technology, Boston, Mass.

Deflection of point 1, with reference to point

Downward, due to load $(P-F_2)$ at point 2 $= \dfrac{5\,A^3(P}{6\,E}$

Upward, due to load F_1 at point 1, $= \dfrac{8\,F_1\,A^3}{3\,E\,I}$

Resultant, downward, $-d_{13} = \dfrac{A^3}{6\,E\,I}(5\,P - 5\,F_2 -$

The difference in deflection of the planking points 1 and 2 is (see Fig. 2)

$$d_{12} = d_{23} + d_{13} = \frac{A^3}{6\,E\,I}(3\,F_2 - 3\,P + 11\,F_1)$$

Equating this with the difference in deflection of stringers 1 and 2, at the center of the panel, we have

$$\frac{L^3}{8\,I_1}(F_2 - F_1) = \frac{A^3}{I}(3\,F_2 - 3\,P + 11\,F_1) \qquad (2)$$

the value of the modulus of elasticity E being the same for stringer and planking.

Similarly, the expression above given for the difference of deflection between points 2 and 3, may be equated to the difference of deflection in the corresponding stringers. This gives the third equation required:

$$\frac{L^3}{8\,I_1}(F_2 - F_3) = \frac{A^3}{I}(2\,P - 2\,F_2 - 5\,F_1) \qquad (3)$$

The solution of equations (1), (2) and (3) gives the following values for F_1, F_2 and F_3:

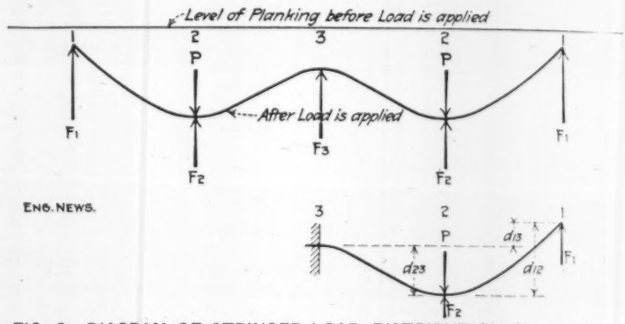


FIG. 2. DIAGRAM OF STRINGER LOAD DISTRIBUTION ON HIGHWAY BRIDGE FLOOR CARRYING ELECTRIC RAILWAY TRACK.

$$F_1 = \frac{2\,P\,L^3\,I\,(20\,A^3\,I_1 + L^3\,I)}{448\,A^6\,I_1^2 + 272\,A^3\,L^3\,I\,I_1 + 5\,L^6\,I^2}$$

$$F_2 = P - \frac{P\,L^3\,I\,(128\,A^3\,I_1 + 3\,L^3\,I)}{448\,A^6\,I_1^2 + 272\,A^3\,L^3\,I\,I_1 + 5\,L^6\,I^2}$$

$$F_3 = \frac{2\,P\,L^3\,I\,(88\,A^3\,I_1 + L^3\,I)}{448\,A^6\,I_1^2 + 272\,A^3\,L^3\,I\,I_1 + 5\,L^6\,I^2}$$

The accompanying table shows some values of the loads F_1, F_2 and F_3 as given by the above formulas. An examination of the table will show that an axle load of 15,000 lbs. has been assumed on a panel length of 13 ft., with stringers spaced 30 ins. apart. The thickness of the planking has been taken as 3 ins., and the axle load has been assumed to be distributed by the rails over 20 ins. of the planking.

The table shows, for example, that for stringers 4 × 14 ins. 7.2% of the axle load is carried by each outside stringer, 30% by each of the stringers under the rails and 25.6% by the stringer under the center of the track.

The above computations have been made to show how the loads are distributed under the most favorable circumstances. Oftentimes the planking is so decayed that it transfers little load to the adjacent stringers, and the stringers directly under the rails carry practically the entire load.

If the loads P are placed at the *end of the panel* instead of at the center, the planking has no effect in distributing the loads over the adjacent stringers and the stringers directly under the rails carry the entire track load.

In designing a new structure of this kind, the

TABLE SHOWING DISTRIBUTION OF LOADS ON STRINGERS OF HIGHWAY BRIDGES CARRYING ELECTRIC CARS

Thickness of planking.	Distribution of load on planking.	Size of stringers.	Spacing of stringers. A	Span of stringers. L	Total load per axle 2 P (lbs).	Load carried by each stringer, pounds— F_1	F_2	F_3	Per cent. of total axle load carried by each stringer— Outside stringer.	Stringer under rail.	Center string
3″	20″	3 × 14″	30″	156″	15,000	1,195	4,816	3,978	8.0	28.8	26.4
3″	20″	4 × 14″	30″	156″	15,000	1,088	4,494	3,836	7.2	30.0	25.6
3″	20″	6 × 14″	30″	156″	15,000	941	4,788	3,542	6.3	31.9	23.6

stringers under the rails should be made of sufficient size to carry the track loads without any assistance from the adjacent stringers.

VIOLENT ERUPTIONS OF VESUVIUS, culminating on April 8, did vast damage to the regions south, west, and north of the volcano. Lava-flows of large volume were emitted from several fissures; the town of Boscotrecase on the south slope was destroyed by a lava stream. Vast amounts of rock and "ashes" have been projected out of the crater and great districts around the volcano are covered. It is reported that the summit of the volcano has been reduced in height by 500 to 1,000 ft. by the eruption.

The town of Ottajano suffered great damage from the showers of stones emitted by the volcano. Probably a hundred or two hundred persons were killed in the vicinity of this place. The worst incident of the eruption, up to the date of writing, occurred in Naples itself on the morning of April 10. The roof of the Monte Oliveto market collapsed under the excessive load of volcanic matter which had accumulated on it, and buried several hundred persons in its ruins. Only a small number has been rescued up to the present, and it seems likely that a large death list will result from the collapse.

CONSPIRACY WITH INTENT TO CHEAT AND DEFRAUD the city of Philadelphia is alleged by the city in a civil suit against the members, past and present, of the contracting firm known as D. J. McNichol & Co., and also against William C. Haddock and Peter E. Costello, ex-Directors of Public Works of Philadelphia, and Mr. John W. Hill, ex-Chief Engineer of the Philadelphia Bureau of Filtration. The city prays the local court to require the defendants to make "full and true discovery" of various facts relating to the copartnership, the contracts secured by the firm, and the estimates of cost, etc., made by Mr. Hill. The city also prays that the various contracts held by the firm, on account of which the city has appropriated $14,703,000 and has actually paid $11,227,665, be declared null and void on account of fraud, and that the defendant be required to account for all money expended in its behalf in the course of the execution of the contracts and "to discover and account for all profits realized from the same;" also that the defendants be ordered to reimburse the city for all losses which it has suffered on account of the alleged frauds. The many contracts awarded to the defendant firm are reviewed in detail and various allegations are made as to fraud perpetrated in the securing or execution of each. The total losses alleged to have been suffered by the city on account of the contracts are put at about $5,000,000. It is alleged that fraud was perpetrated by stifling honest and equal competition; by cornering the market on sand and other materials needed for construction; by fraudulent allowances for work and material, both as to quantity and quality; and by other means. Among the alleged methods of stifling competition, the complaint mentions the letting of contracts to the defendant firm while one of its members was a member of the select branch of the city council; fraudulently prepared and interpreted specifications; readvertisement of bids when the defendant firm was not the lowest bidder; and by "the rigorous enforcement in unimportant particulars of the specifications" against competing bidders to whom contracts were awarded. Particular stress is laid upon making short time-limits an element in favor of the bids submitted by the defendant firm, and then never collecting liquidated damages, as provided, for failure to complete the contracts within a specified time. The alleged conspirators, aside from the city officials mentioned, were: Israel W. Durham, until recently State Insurance Commissioner of Pennsylvania; James P. McNichol, now State Senator of Pennsylvania and formerly of the Philadelphia council; the wife of Mr. McNichol, in whose name the interest in the firm was held while he was a councilman; Daniel J. McNichol, a brother of the Senator; and John M. Mack, sometimes known as the "asphalt king." Preparations for bringing the suit have been under way for some ten months past. The case has been in charge of Mr. James G. Gordon, Special Counsel for Mayor Weaver. It is brought before three judges in one of the local courts, who are said to be eminently qualified for giving it a proper trial. The full text of the bill of complaint is given in the Philadelphia papers for April 7, in which it occupies about a page.

HIGH WATER was the cause of a work train on the Wyoming Division of the Chicago & Northwestern Ry. dropping into a small stream near Natrona, Wyo., on March 26. Six men were killed and twenty-one injured. The engine passed safely over the stream, but its weight broke down the undermined piling and the cars dropped into the ravine, the passenger coach being telescoped by a water car.

THE HOTEL ZUM HIRSCH, Nagold, Little Black Forest, Germany, collapsed April 5, killing or wounding nearly all of the 200 guests present. The building was undergoing repairs and had been raised five feet from the ground in order to make the lower story higher. At the time of the accident the work was supposed to be complete and the hotel proprietor had invited the workmen and a large number of townspeople to a dinner. The guests were all assembled in the banquet room when a crash was heard above and the house crumbled into a heap of ruins.

ANOTHER MINER RESCUED FROM THE COURrieres mine, Department Pas de Calais, France, was brought to the surface on April 4, after having been entombed 25 days. The same day a horse was found alive in the mine, and a number of bodies of men, dead only a few hours, were discovered.

THE ATCHISON, TOPEKA & SANTA FE RY. is spending some $7,000,000 on new equipment, having ordered 24 locomotives of the Atlantic type balanced compound, 15 Pacific type balanced compound, 12 Santa Fe type tandem compound, half to be coal and half oil-burning, and 49 six-wheel connected switching engines. There is also ordered 4 standard dining cars, 2 café observation cars, 25 standard day coaches, 22 partition day coaches, 30 smoking cars of the latest design, 60 standard baggage cars of the steel-underframe class, and 39 steel-underframe mail cars. In addition to above equipment there will be the following steel-underframe cars: 4,500 standard box cars, 850 drop-bottom coal cars, 450 Rodgers ballast cars, 1,250 flat cars, 100 side-dump cars, 1,000 drop-bottom stock and coke cars, and 300 furniture cars. A few of the above cars will replace old ones, but the majority are intended for handling new business.

ONE OR MORE CIVIL OR SANITARY ENGINEERS on every local board of health, and one or more "persons trained in engineering" among the agents of every such board was urged by Prof. Wm. T. Sedgwick, of the Massachusetts Institute of Technology in a recent address at Richmond, Va., on the "Hygiene and Sanitation of a Modern City."

PERSONALS.

Mr. D. H. Wilson, Jr., has been appointed Electrical Engineer for the Erie R. R.

Mr. Chas. D. Wierbach, of the Lehigh Engineering Co., Allentown, Pa., has been elected City Engineer of Allentown.

Mr. J. O. Ely succeeds Mr. E. L. Cruger, resigned, as Assistant Engineer, Louisville & Nashville R. R., at Knoxville, Tenn.

Mr. R. T. Guppy has been appointed Principal Assistant Engineer of the Union Pacific R. R., with headquarters at Omaha, Neb.

Mr. A. J. Wemzell has been appointed Consulting Engineer and General Manager of the Gabriel Concrete Steel Co., Detroit, Mich.

Mr. O. M. Laing has been appointed Superintendent of the Central New England Railway, with headquarters at Hartford, Conn.

Mr. Van Franck has been appointed Superintendent of the Petaluma & Santa Rosa Ry. Co., to succeed Mr. E. E. Thornton, resigned.

Mr. E. B. Temple, who has been Assistant to the Chief Engineer of the Pennsylvania R. R., has been given the title of Assistant Chief Engineer.

Mr. Robert G. Dieck, acting City Engineer, has been appointed City Engineer of the Municipality of Manila, P. I. He was formerly Superintendent of Water-Works.

Mr. H. B. Baylor has accepted the position of Chief Engineer of A. Cohn & Co.'s large tobacco plantation in southwestern Georgia. His address is Amsterdam, Ga.

Mr. Thomas A. Ferneding, Assistant Superintendent, Dayton & Xenia Traction Co., of Dayton, O., succeeds Mr. A. W. Anderson, resigned, as General Superintendent.

Mr. C. M. Campbell, Electrical Engineer, Pittsburg & Lake Erie R. R., has resigned to accept the position of Assistant Superintendent of the Western Electric Co., Chicago, Ill.

Mr. B. B. Lathbury, M. Am. Soc. C. E., formerly senior member of Lathbury & Spackman, has opened offices in the Land Title Bldg., Philadelphia, Pa., as a Consulting Engineer.

Mr. Joshua B. F. Breed has resigned as City Engineer of Louisville, Ky., to become Chief Engineer for the Commissioners of Sewerage of Louisville, Ky. He assumes his new duties April 16.

Mr. Chas. Wainwright, Superintendent of the Blaisdell Machinery Co., Bradford, Pa., and formerly with the Ingersoll-Sargeant Drill Co., of Easton, Pa., has accepted the position of Superintendent of the Bury Compressor Co., Erie, Pa.

Mr. Wm. Grant, late of the Engineer's office of the Chicago, Burlington & Quincy Ry. Co., has been appointed City Engineer of Lincoln, Neb., to succeed Mr. Geo. L. Campen, resigned. Mr. Champen goes to Panama as Water Commissioner of the Canal Zone.

Mr. J. L. Adams, M. Am. Soc. M. E., Superintendent of the Hartford, Manchester & Rockville Tramway Co., Hartford, Conn., has resigned to accept the position of Superintendent of the railway company operating lines in the cities of Columbus and Dayton, O.

Dr. Charles B. Dudley, Chief Chemist of the Pennsylvania R. R. for many years, and well known among engineers and scientists, both here and abroad, is to be married on April 17 to Miss Mary V. Crawford, of Byrn Mawr, Pa. Dr. Dudley's host of friends in the engineering profession will unite in tendering their congratulations.

The following changes have taken place in the Reclamation Service: Mr. J. Owen Ambler and Mr. Jesse W. Benson, Engineering Aids, have resigned; Mr. Alden M. Sprigg has been appointed Engineer and assigned to duty with Mr. C. C. Babb, on St. Mary Project, Mont.; Mr. John E. Liebfried has been appointed Cement Expert and assigned to duty with Mr. J. Y. Jewett at Denver, Colo.

Mr. John C. Brackenridge, M. Am. Soc. C. E., has been appointed Consulting Engineer of the New York Central & Hudson River R. R. Mr. Brackenridge was formerly General Manager and Chief Engineer of the Brooklyn Rapid Transit Ry. and is President of the Rossiter McGovern Co. His time will be devoted to those lines of the Central on which the motive power is to be changed from steam to electricity.

Mr. George W. Kittredge, M. Am. Soc. C. E., Chief Engineer, Cleveland, Cincinnati, Chicago & St. Louis Ry., has just been appointed Chief Engineer of the New York Central & Hudson River R. R., with headquarters in New York City. Mr. Kittredge is also Chief Engineer of the Peoria & Eastern Ry. and the Louisville & Jeffersonville Bridge Co. He was a charter member of the American Railway Engineering and Maintenance of Way Association and its second President.

Mr. Mark M. Murtagh, Assistant General Manager, Twin Falls Land & Water Co., with headquarters at Salt Lake City, Utah, and Twin Falls, Idaho, has resigned to become Chief Engineer of The Sao Paulo Tramway, Light & Power Company, Limited, Sao Paulo, Brazil, with headquarters at Sao Paulo and Santo Amare. Mr. Murtagh is well known in Colorado, Nevada, Utah, Montana and Idaho as a Hydraulic Engineer, having completed one of the largest dams and largest irrigation projects in the United States.

Mr. Charles M. Muchnic has been made Manager of the Foreign Department of the American Locomotive Works, New York City, and will have charge of the details of the foreign business. Mr. Muchnic has been connected with some of the best American and European locomotive manufacturers. He has made several trips to Europe in the interests of American locomotive builders, and also accompanied Mr. R. J. Gross, of the American Locomotive Co., on his trip around the world in 1903, which gives him an acquaintance with railroad officials in all parts of the world.

Obituary.

William Wallace died at Greenwich, Conn., April 4, of apoplexy, aged 66 years. He was for many years Assistant Superintendent of the New York Division of the New York, New Haven & Hartford R. R.

Robert Miller died at Detroit, Mich., March 13, aged 66 years. He was formerly Superintendent of Motive Power and Equipment for the Michigan Central R. R., having advanced successively from Master Car Builder, Assistant General Superintendent and General Superintendent.

Alson H. Pomeroy died April 2 at Berea, O., of apoplexy. He was born at Strongsville, O., March 7, 1836. Mr. Pomeroy was known throughout northern Ohio in the railway traction field, having organized the Cleveland & Southwestern Traction Co., of which he was president until four years ago, when he was forced to retire by a stroke of apoplexy.

Augustus Olsen Bostrom, who died in Washington, D. C., March 23, was born at Dalkarka, Sweden, in 1846. He removed to the United States in 1869 and in 1877 graduated from Rensselaer Polytechnic Institute, Troy, N. Y. Mr. Bostrom, who had long been in the employ of the government, designed the steel barbette turret now used on United States battleships and had recently designed a new type of caisson for dry docks.

William B. Rider died April 10, at Sanford Station, Conn., of apoplexy. He was 64 years of age and had long been associated with engineering work. He designed and constructed the water-works systems for the cities of Norwalk, Conn., Orange, N. Y., and Oneonta, N. Y., together with numerous sewerage, filter and water-works systems in other parts of the country. Mr. Rider was for many years city engineer of South Norwalk, and was also a member of the Connecticut state board of engineers.

Thomas R. Almond, M. Am. Soc. M. E., died at his home in Dundwoodie Heights, Yonkers, N. Y., on March

31, of pneumonia. He was born at Rocklandshire, England, in 1845, but removed to the United States in 1868. Mr. Almond was a versatile inventor and was twice awarded the John Scott medal by the Franklin Institute, he being the only person ever so honored. He was a charter member of the American Society of Mechanical Engineers, and a member of the American Association for the Advancement of Science.

W. A. Stevenson, a graduate of Lehigh University in the class of 1888, and long an officer of the Lehigh Valley R. R., died at El Paso, Tex., on April 3 from tuberculosis. Mr. Stevenson took the mechanical engineering course in the university and soon after graduation became an Assistant Editor on the staff of Engineering News. His very attractive personal qualities won him the friendship of his associates; but after a few months he resigned his position to accept a very favorable offer from the Lehigh Valley R. R. Co., of which an uncle was at that time General Superintendent. He remained in the service of the company for ten years, rising to the position of General Superintendent. In 1898 his health made advisable removal to a milder climate and he went to Mississippi, where he became General Manager of the Mississippi Central Ry., with headquarters at Hattiesburg, Miss., and also held an important interest in the lumber business there. The development of the disease which resulted finally in his death compelled him to give up active business in 1903, and he removed to El Paso, where he has since lived. Mr. Stevenson was married in 1891 to Grace Merriam, of Waverly, N. Y., and she, with three children, survive him.

Nathaniel Southgate Shaler, of Cambridge, Mass., Dean of the Lawrence Scientific School and Professor of Geology in Harvard University, died on April 10. He had been sick for some days from pneumonia, following directly after an operation for appendicitis. He was born in Newport, Ky., in 1841, and graduated from the Lawrence Scientific School in 1862. He served two years in the artillery on the Federal side during the Civil War. He had been connected with Harvard since 1864, having been made instructor in zoology and geology in 1868, Professor of Geology in 1887 and Dean of the Lawrence Scientific School in 1891. From 1873-9 he served as Director of the Kentucky Geological Survey. From 1886 to 1900 he was connected with the U. S. Geological Survey. For a number of years he was a member of the Massachusetts State Highway Commission. Besides official reports and a large number of papers, essays and magazine articles, Professor Shaler wrote many books treating of geology, history, various phases of sociology, and he also made some excursions into pure literature. The most notable example of the latter was the production, a few years ago, of a dramatic work of five volumes entitled "Elizabeth of England." A book of verse by Professor Shaler is now in press. In 1896 he published "American Highways," an excellent and practical volume on highway construction and related subjects. His latest published volume was "Man and the Earth," reviewed in this journal for March 15, 1906.

Henry Williams Parkhurst, M. Am. Soc. C. E., died in Chicago on April 7, death resulting from a fracture of the skull sustained Feb. 20, when he was struck by a train. He was born in Boston, Mass., in 1847, but his early life was spent in Providence, R. I., where his family belonged, being descendants from Roger Williams of the "Providence Plantations." He graduated from Brown University in 1869, and began his professional career in the office of Mr. S. B. Cushing, a civil engineer at Providence. In 1870 he was engaged on the double-track work for the Providence & Worcester Ry. In 1871 he was Assistant Engineer and later Resident Engineer on the Hannibal Bridge over the Mississippi River, Mr. E. L. Corthell being Chief Assistant Engineer. After this he was Resident Engineer under Mr. Corthell (Chief Engineer) for the Sny Island Levee, in Illinois. In 1873-74 he was Resident Engineer of the Mississippi River bridge at Louisiana, Mo. (again under Mr. Corthell), and in 1876 he was engaged with the latter on some of the work for the South Pass jetties at the mouth of the Mississippi. He served under the late George S. Morison (Chief Engineer) as Resident Engineer for the Plattsmouth Bridge in 1879-80, the Bismark Bridge in 1881-82, and the Blair Crossing Bridge in 1882-83. In 1883-84 he was engaged in surveys for a railway in Venezuela, but the road was not built. He was Assistant Engineer in charge of foundations of the new Omaha Bridge in 1885, but in December of that year he met with an accident which necessitated the amputation of his left leg. From 1885 to 1889 he was in charge of the construction of the Merchants' Bridge at St. Louis, under Mr. Morison. In 1892 Mr. Parkhurst entered the service of the Illinois Central Ry. as Engineer of Bridges and Buildings, though at one time his title was Engineer of Construction. In his 14 years of service with this road he designed and built the shops at Burnside (Chicago), Water Valley, Waterloo and Memphis, and the Stuyvesant terminals (docks, elevators, wharves, etc.) at New Orleans; he had charge of the rebuilding of the La Salle, Dubuque and Tennessee River bridges, and the Chicago track elevation and depression, designing the steel bridges with terra-cotta protection which carry the streets over the depressed tracks on the Lake Front. Among a number of concrete bridges, he designed and built the Big Muddy bridge at Carbondale, Ill., which was notable at the time on account of the use of spandrel arches, and was described by him in an article in Engineering News, Nov. 12, 1903. In 1905 he opened an office for private practice in Chicago, but retained his connection with the Illinois Central R. R. in a consulting capacity. Mr. Parkhurst became a member of the American Society of Civil Engineers in 1897, and was a charter member of the American Railway Engineering and Maintenance of Way Association. He was a member of the Western Society of Engineers since 1879, and was Vice-President in 1903, and President in 1904. In 1871 he was married to Miss L. F. Crandall, of Providence, R. I., who died in 1881. In 1889 he married Miss Annie H. Horine, of Chicago, who (with two sons and one daughter) survive him.

ENGINEERING SOCIETIES.

COMING MEETINGS.

IOWA ELECTRICAL ASSOCIATION.
April 18 to 20. Annual meeting at Des Moines, Ia. Secy., Geo. S. Carson, Iowa City, Ia.

NATIONAL MUNICIPAL LEAGUE.
April 24 to 27. Annual meeting at Atlantic City, N. J. Secy., Clinton Rogers Woodruff, North American Bldg., Philadelphia, Pa.

AMERICAN RAILWAY ASSOCIATION.
April 25. Semi-annual meeting at Chicago, Ill. Secy., W. F. Allen, 24 Park Place, New York City.

AMERICAN ELECTROCHEMICAL SOCIETY.
May 1 to 3. Annual meeting at Ithaca, N. Y. Secy., S. S. Sadtler, 39 South 10th St., Philadelphia, Pa.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
May 1 to 4. Semi-annual meeting at Chattanooga, Tenn. Secy., F. R. Hutton, 12 West 31st St., New York City.

NATIONAL FIRE PROTECTION ASSOCIATION.
May 22 to 24. Annual meeting at Chicago, Ill. Secy., W. H. Merrill, Jr., Chicago, Ill.

NATIONAL ELECTRIC LIGHT ASSOCIATION.
June 5. Annual meeting at Atlantic City, N. J. Secy., W. C. L. Eglin, 136 Liberty St., New York, N. Y.

AMERICAN FOUNDRYMEN'S ASSOCIATION.
June 5 to 7. Annual convention at Cleveland, O. Secy., Richard Moldenke, Watchung, N. J.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.
June 18. Annual convention at Atlantic City, N. J. Secy., J. W. Taylor, Old Colony Bldg., Chicago, Ill.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
June 26. Annual convention at Thousand Islands, N. Y. Secy., Chas. Warren Hunt, 220 West 57th St., New York, N. Y.

AMERICAN WATER-WORKS ASSOCIATION.
July 10 to 14, inclusive. Annual meeting at Boston, Mass. Secy., J. M. Diven, 14 George St., Charleston, S. C.

CENTRAL ELECTRIC RAILWAY ASSOCIATION.—The March meeting was held at Indianapolis, Ind., on March 22. A paper on "Electric Railway Signals" was read by Mr. E. J. Burke, describing the Blake semaphore signal. This semaphore is operated by the dispatcher and it gives a return signal in the dispatcher's office when it operates. The system is now in use on lines in Illinois and Indiana. A paper on "Improvements in Air Brakes," describing among other matters the brake systems of the New York and Boston elevated railways, was read by Mr. W. V. Turner, Mechanical Engineer of the Westinghouse Traction Brake Co. The next meeting will be held at Columbus, O., on May 24.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—The 53d meeting of the Society will be held at Chattanooga, Tenn., May 1 to 4, 1906. Headquarters will be at the Read House.

The feature of greatest interest in the professional work of the convention will be the devotion of an entire session on Thursday morning to the governing of water power plants. Papers have been prepared and discussions promised by leading designers and makers of speed governors for water-wheels. The local excursions during the meeting will include trips to Lookout Mountain, Missionary Ridge, Hale's Bar, where a 50,000-HP. hydraulic power plant is under construction, and the Chickamauga National Park.

TECHNICAL PUBLICITY ASSOCIATION.—The second annual meeting and banquet of the society was held in New York City, April 5, at which time the following officers were elected: President, F. H. Gale (General Electric Co.); 1st Vice-President, H. M. Cleaver (Niles-Bement-Pond Co.); 2d Vice-President, C. B. Morse (Ingersoll-Rand Co.); Secretary, Rodman Gilder (Crocker-Wheeler Co.); Treasurer, H. M. Davis (Sprague Electric Co.); Members of the Executive Committee, Robt. L. Winkley (Pope Mfg. Co.), and G. M. Basford (American Locomotive Works); Members of Election Committee: C. W. Beaver (Yale & Towne Mfg. Co.); Chas. W. Manfred (Johns-Manville Co.); and H. H. Kress (A. S. Cameron Steam Pump Works).

THE NATIONAL MUNICIPAL LEAGUE will hold its twelfth annual meeting and the fourteenth national conference for good city government at Atlantic City, April 24 to 27. Hotel Chalfonte will be headquarters for visitors as well as place of all meetings. The convention will open Tuesday afternoon with addresses of welcome by Hon. Frank P. Stoy, Mayor of Atlantic City, and Henry W. Leeds, President of the Council. After routine business Charles Richardson will read a paper on "United Cities Platform," and Richard Henry Dana will follow with one on "Ballot Reform and the Massachusetts Law." Tuesday evening and Thursday afternoon will be devoted to a Round Table Conference for the discussion of papers and ways and means of conducting local work. Papers on "Municipal Experiences and Conditions" will be read by A. Julius Frieberg, Lawrence Veiller, Lucius B. Swift, James H. Causey, Thomas Raburn White, Edmund Billings, E. R. Cheesborough, Fairfax Wheelen; "Juvenile Civic Activity," W. Chauncey Langdon; "The Police Question," Dr. Eugene M. Hartwell; "The Acceptance of Municipal Accounting Reform," Hon. L. G. Powers; "Ohio's Experience with Uniform Accounting and Reporting," A. R. Pepaugh; "The Referendum and the Initiative," Louis F. Post; "Corrupt Practices," Horace E. Deming; "Municipal Ownership and Operation in American Cities will be discussed by Philip J. Loftus, Hon. J. M. Barrs, Frederick F. Ingram, L. N. Case, Hon. Frederick C. Howe and E. E. Bennett. Prof. L. S. Rowe will read a paper on "The Value of Foreign Experience," and Harvey S. Chase one on "Illustrative Experiences in Massachusetts."

WESTERN SOCIETY OF ENGINEERS.—At the meeting on April 4, Mr. A. W. Merrick, Assistant Engineer of the Chicago & Northwestern Ry., presented a paper on "The Clay Slide at the Boone Viaduct," a structure carrying a railway line across the valley of the Des Moines River. This valley is 180 to 200 ft. deep and cuts through the glacial drift and the underlying series of thin, level beds of clay, shale, coal, fireclay and sandstone. The slide occurred in the mixed clay of the glacial drift in the vicinity of the upper piers on the east bank, and was first observed in June, 1905. In some places the vertical slip amounted to 2 ft. or more, and the material rolled up below in a mud wave. In some places the soft ground and these mud waves made walking impossible. In order to prevent further sliding, Mr. Carter, the Chief Engineer, developed a plan for draining the side hill. Three parallel main ditches 230 to 361 ft. long, were cut along the slope, with lateral branches between them. The main ditches are 5 ft. wide on the bottom, and varied in depth from 9 or 10 ft. at the upper end to 4 ft. at the lower end. The ditches were then filled with 3 ft. of "one-man" riprap stone and 2 ft. of willow brush, covered with backfilling. Struts of pairs of 8 × 16-in. timbers were placed between two of the piers as a precaution against movement. This treatment of the slide proved effective, the ground having dried out and slipping stopped. The cost of the work was $7,150.

In the discussion, Mr. Tratman (Engineering News) referred to the frequent use of stone-filled trenches to drain the slopes of cuts on European railways. He also described two particular cases in France, in one of which extensive underground galleries connected with surface drains by shafts or wells were employed to carry away the surface water below the level of the treacherous strata upon which banks and even masonry structures rested. In the other case, a railway built along the side of a valley and ascending to the plateau above cut the strata in such a way that it very soon became a series of sliding cuts and settling banks. In some cases areas of 50 or 60 acres slid bodily (with a thickness of 30 to 40 ft.) and filled the cuts. The contractors abandoned the work in despair, and the engineers then entered upon a costly scheme for draining and consolidating the ground, with such success that in only one case was a diversion from the original location necessary. In this case, a long side-hill cut had started a slide of enormous extent, and the line was therefore thrown back into the hill, so as to pass in a tunnel through the undisturbed ground behind and below the slide. In some cases where rock cuts caused constant falls of stone from the hillside, the cuts were arched over, the masonry arch being covered with a bed of earth filling. Where these were sidehill cuts, masonry galleries were built, the arched roof being supported at one side by the cut and at the other side by a wall pierced with a series of arched openings. The exploratory works carried out to ascertain the exact conditions of the strata underlying the most troublesome places were very extensive; as were also the works for draining the areas affected. He also referred to the peculiar experiences with slides of irrigated lands along the Canadian Pacific Ry., as noted in Engineering News of Jan. 8, 1903.

In regard to railway construction along the slopes of valleys, Mr. E. C. Carter, Chief Engineer of the Chicago & Northwestern Ry., stated that before the Boone Viaduct was built the railway was developed along the sides of the valley to a low-level bridge over the Des Moines River. This resulted in cutting the various beds or strata, and numerous slides occurred. These were checked by laying wooden trough drains up the slopes of the sidehill cuts to carry the water down and remove it from the ground. Mr. Zinn referred to the use of tile drains in work of this kind, but it was shown that in sliding ground these drains might easily be broken and filled up, while the stone-filled trenches are not easily affected.

ENGINEERING LITERATURE

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CONTENTS.

REVIEWS:
A New Edition of Bovey's Structures. Reviewed by Geo. F. Swain 425
Kidder's Trussed Roofs and Roof Trusses. Reviewed by Henry S. Jacoby..... 426
Die Wetterbeständigkeitsprobe der Bausteine..... 426
Steam Turbines. Reviewed by Storm Bull..... 427
Geschichte der Grössten Technischen Erfindungen. 427
Refrigerating Machinery. Reviewed by J. C. Bertsch 428
Méthodes de Combustion dans les Chaudières à Vapeur 429
Electrical Books. Reviewed by H. H. Norris 430
House Hints 431
Die Schiffsschraube. Reviewed by D. W. Taylor. 432
Pattern Making. Reviewed by W. W. Bird 433
The Steam Engine Indicator 433
Eminent Engineers 433
Underground Water Resources of Long Island.... 433
Literary Magazines 434
Publications Received 434

A New Edition of Bovey's Structures.

Reviewed by George F. Swain.*

THEORY OF STRUCTURES AND STRENGTH OF MATERIALS.—By Henry T. Bovey, M. A., LL. D., D. C. L., F. R. S., M. Inst. C. E., Professor of Civil Engineering and Applied Mechanics, McGill University, Montreal. Fourth Edition, rewritten and enlarged. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 6 × 9¼ ins.; pp. 968; 943 figures in the text. $7.50, net.

About 130 pages have been added to the already bulky volume of 830 pages comprising the third editon of this book. The most striking feature of the work is the very large number of examples presented at the ends of the several chapters. There are no fewer than 1,500 of these, covering over 200 pages. Most of the examples are accompanied by answers.

The book, as its title indicates, is an attempt to cover in one volume subjects which are generally, and, in the opinion of the reviewer, better, separated. It apparently aims to be a treatise on mechanics, the strength of materials, friction, framed structures, masonry, and, to some extent, on machinery. The subjects of toothed gearing, dynamometers, belts and ropes appear, although they are not usually included in works on structures.

The book contains a large amount of information and a theoretical discussion of many points which are of value to the engineer. Its principal defects appear to be an illogical and confusing arrangement and a lack of clearness, simplicity and concreteness in many of the discussions.

Chapter I. treats of framed structures. Beginning with simple triangular frames, the equilibrium polygon is briefly referred to, as well as centers of gravity and moments of inertia; then a couple of pages are introduced with reference to loads and wind pressure on roofs; then a few simple trusses, such as crane trusses and roof trusses, are taken and the diagrams drawn; then bridge trusses are touched upon and diagrams drawn, and, finally, the three-hinged arch is brought into this chapter in a brief five pages. In the examples following this chapter are a three-hinged roof of 320-ft. span, cantilevers, draw-bridges, two-hinged arches, and piers of large dimensions. The reviewer does not believe that the student could possibly be expected to gain from the text of the chapter anything like the information necessary to enable him to treat intelligently the examples shown. The fundamental principles upon which framed structures are to be solved are not stated with sufficient clearness and emphasis, and not sufficiently contrasted with each other, to enable a student to understand their use, considering the preparation he is evidently supposed to have had before beginning the work. This will be clear when it is noted that the second chapter deals with shearing forces and bending moments, with which the student should be thoroughly familiar before entering upon the study of framed structures. Curved chord bridges with subdivided panels and cantilever bridges cannot be thoroughly understood without a previous training in the use of influence lines and other diagrams and in the laws governing shears and moments.

Chapter II. deals with shearing forces and bending moments. It should have come before Chapter I. Ordinary cases of loading are treated, both fixed and movable, but the subject might have been somewhat simplified. Chapter III. is on momentum, energy and balancing. Acceleration, work, energy, impulse, momentum, balancing, the action of piston and cranks are taken up. This chapter, while valuable in itself, would seem to have little organic connection with the rest of the work. Chapter IV. treats of stress and strain. The theory of vibration is worked out with more elaboration than is necessary for the structural engineer, and in connection with Fatigue Launhardt's and Weyrauch's formulae are given. The material of this chapter is well presented.

Chapter V. is devoted to the theory of elasticity and its application to earth pressure and to a discussion of retaining walls, reservoir walls and thick cylinders. The reviewer is glad to see the theory of elasticity treated in direct connection with two of its most important applications—shafting and earth pressure. The general method of treatment of the ellipse of stress and of conjugate stresses is that of Rankine. Altogether, the chapter is a good one, although it seems a little anomalous again that the subjects of the theory of elasticity, earth pressure work and retaining walls should be treated before taking up simple beams, which come later. Chapter VI. treats of friction, with applications to the wedge, screw, rolling friction, journal friction, pivots, belts and ropes, dynamometers and toothed gearing. It is rather unique to find these subjects brought into such close connection, or even in the same volume, with a detailed treatment of the general subject of framed structures.

Chapter VII., one of the fullest chapters of the book, comprising 130 pages of text and 47 examples, is devoted to the transverse strength of beams. The special case in which the loads lie in the plane of one of the principal axes is the only case treated, although there is a brief reference to the more general problem. It would have been well if the latter had been adequately treated and the modern developments given as regards neutral axis, kernel, etc. Reinforced concrete beams are allowed one page, with two pages of examples, formulae for no tension on the concrete and for a straight line compression distribution being given. The discussion of this subject is much too brief, no mention being made of the holding power of rods, the effect of shear, etc. The distribution of the shearing stress on the cross-section of a simple beam is taken up, but the relation between the horizontal and vertical shearing forces is not sufficiently emphasized to enable the ordinary student to clearly understand this part of the subject. It is a cause for disappointment, also, that the subject of direct stress combined with flexure is not more adequately treated. Stresses in flanged girders, including cast-iron girders and built-up girders, are then considered, with an example of the computation of a plate girder 50 ft. in span. In this discussion no mention appears to have been made of the action of the web in buckling, or of lateral deflection of the flanges, and of other matters of practical importance. This chapter contains, also, a discussion of the relations between the deflection, slope, and bending moment, and the graphic determination of the slope and deflection; and, finally, the subject of continuous girders is taken up, the theorem of three-moments deduced and applied to a French bridge of three spans, and to a draw-span. There is no discussion, however, in this connection of the different methods of supporting draw-spans and of the effects of such methods upon the stresses. The advantages and disadvantages of continuous girders are pointed out, but some of the statements are rather obscure, as, for instance, the following statement with reference to fixing the point of inflexion absolutely:

> The *fixing* may be effected in the following manner:
> (a) A *hinge* may be introduced at the selected point. The benefit of doing so is very obvious when circumstances require a wide center span and two short side spans.
> (b) If the web is open, i. e., lattice-work, the point of inflexion in the upper flange may be fixed by cutting the flange at the selected point and lowering one of the supports so as to produce a slight opening between the several parts. The position of the point of inflexion in the lower flange is then defined by the condition that the algebraic sum of the horizontal components of the stresses in the diagonals intersected by a line joining the two points of inflexion is zero.

Such a statement should be made clear, and requires further explanation before the ordinary reader will be able to understand what the author means.

Chapter VIII. treats of columns, describing the different causes of failure and discussing the ordinary formulae. An example of the rather frequent lack of clearness into which the author allows himself to fall is found in the treatment of Gordon's and Rankine's formulae, in which the student is apparently left to infer that both are correct, or rather fails to see how one is more correct than the other. Again, under the straight-line formula, the author says: "No provision is made in this formula for the detrimental effect of repeated stresses," implying that there is a distinction in this respect between the straight-line formula and those of Gordon and Rankine. Considerable space is given to a discussion of Euler's formula, and in the course of the general discussion the use of "elliptic integrals" is encountered, which will not be understood by most engineering students.

Torsion and its application to shafts, helical springs, etc., is treated in Chapter IX. The author indulges in a rather elaborate mathematical discussion of the centrifugal whirling of shafts and the effect of the centrifugal force upon the stresses.

The general subject of bridges is given a chapter of 108 pages of text and 22 pages of examples, together with 36 pages devoted to illustrations of the design of a 127-ft. truss and of a 520-ft. swing-span. The different types of bridges are first classified (which it would seem might well have been done in the first chapter), and we find here, for the first time, definitions of panels and panel points, although, as we have seen, the first chapter in the book deals with trusses as complicated as the three-hinged arch. The subject of pins is treated in this chapter, but quite inadequately. The maximum bending moment upon the pin (in either a vertical plane or a horizontal plane) is here taken as the moment of a couple, one of whose equal forces is the resultant force (vertical or horizontal) in one direction on one side of the center of the pin and the other the equal resultant in the other direction. These resultants are found and the arm of the couple is taken as the distance between them, which is evidently an incorrect method. According to it, if the resultant horizontal force to the right on one side of the center were in the same line with the resultant horizontal force to the left, there would be no horizontal bending moment. In this chapter, under the discussion of stresses, there is much material which should have been placed in connection with that subject in Chapter I. It is also to be noted that in the case of trusses with double systems of web the vertical shear is divided between all the diagonals cut by a vertical section, with no explanation as to the error in this

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assumption. Some further errors into which the author has allowed himself to fall may be noted, as, for instance, in the treatment of the parabolic truss, where a distinction is made between the treatment of such a truss in which the bow is actually curved and one in which it is a polygon. This confusion arises because the word truss is nowhere defined, so far as the reviewer observed. This chapter proceeds to treat the three-hinged arch once more, although this structure, as already stated, was taken up in Chapter I., and an example given in this at the end of that chapter of the design of a dome of 320 ft. diameter and a three-hinged suspension bridge of 128-ft. span. Wind pressure is next taken up, although in Chapter I. roof trusses are supposed to have been figured. Cantilevers are once more treated, though somewhat meagerly, and, finally, riveted joints, but rather more with reference to boiler work than to structures. The chapter is completed by the two designs above referred to, which are worked out in some detail.

Chapter XI. deals with suspension bridges. The final chapter treats of arches and arched ribs, including arches of stone (28 pages) and arches of metal. In the discussion of the stone arch, Moseley's principle is stated as apparently correct in its application to this structure.

Summing up, the book contains a very large amount of information, and will be useful as a book of reference for those familiar with the subject, but is very poorly arranged and there is a lack of emphasis on fundamental principles. The student is not given a framework of principles upon which to hang the details, and simple principles are often either not clearly stated or are obscured by a too mathematical presentation. The reviewer has not observed in the book any treatment of influence lines, portals, sway bracing, least work and other topics of importance to the structural engineer, which might well have been given in place of some subjects of less importance. A good point in the work is its large collection of examples, which many teachers will find useful in their classes. The ordinary student, in taking up a new subject, will gain the greatest help from a book in which fundamental principles are clearly laid down and illustrated, different methods clearly stated and contrasted, and in this way a substantial foundation given upon which further details and more exhaustive information may be based. A logical arrangement is therefore of much importance. It is a cause for regret that the accomplished author of this book did not more fully meet this desideratum, and it is hoped that in future editions he may see fit to rearrange the work.

Trussed Roofs and Roof Trusses.

Reviewed by Henry S. Jacoby.*

BUILDING CONSTRUCTION AND SUPERINTENDENCE.—By F. E. Kidder, C. E., Ph. D., F. Am. Inst. Archs., Author of "The Architects and Builders' Pocket Book." Part III. Trussed Roofs and Roof Trusses. Section I. New York: William T. Comstock. Cloth; 6½ × 9¾ ins.; pp. 297; 306 figures in the text and one plate. $3.

It is a pleasure to take up a volume that, upon even a cursory examination, gives one such a marked impression of the wealth of its contents and which is fully confirmed after a thorough investigation.

Chapter I., covering 41 pages, is devoted to a description and illustration of types of wooden trusses and the mechanical principles involved in their construction. The illustrations include more than thirty examples of trusses that may properly be claimed to represent the best construction in this class. The complex frames of earlier times which have been so prominent in books on carpentry and building are entirely omitted, and rightly so, since it was practically impossible to determine their stresses and to design their members rationally. A valuable feature of the text consists of brief statements on the economical limits of span and proportions that govern the construction of the different types of trusses.

Chapter II. is 28 pages in length, and deals in a similar manner with types of steel trusses having either riveted or pin connections, and includes the three classes of simple, arched and cantilever trusses. Over forty examples of trusses are illustrated, mostly drawn from actual cases, and showing the most economical arrangements for different spans, ranging from 20 to 368 ft.

Chapter III. has 20 pages on the layout of trussed roofs and on the bracing of roofs and trusses. The discussions on the type of truss to be used, the pitch of the roof, the spacing of the trusses and of the purlins are taken up in connection with different classes of buildings or forms of construction in either wood or steel. The most noteworthy feature in this and the two subsequent chapters consists of more than a dozen isometric drawings, which show in an unusually effective manner the relation of the trusses to the other details of the framing for roofs and ceilings of different forms. Some interesting examples of roofs supported by longitudinal trusses are shown—a method of construction that might well be employed more frequently. Another uncommon arrangement is that of a pyramidal truss, supporting the roof and ceiling over a large room of a school building.

In Chapter IV. the author treats open timber roofs and church roofs. The sub-topics in its 37 pages are exposed scissors trusses, open timber roofs with hammer-beam trusses, church roofs with suspended ceilings, manner of supporting the ceiling, roofing the crossing, and level ceilings. Economic and other practical considerations accompany the discussion of relative advantages of the various types of trusses for different spans and building requirements. The illustrations are elaborate, including half-tone views, perspective sketches, isometric drawings, and dimensioned detail drawings of roof trusses, as well as partial plans of truss layouts.

Under the general heading of vaulted and domed ceilings, octagonal and domed roofs, Chapter V. gives, in the limits of 42 pages, an illustrated description of vaulted ceilings under steep-pitched roofs, longitudinal trusses for vaulted ceilings, ceilings with cross or groined vaults, steel trusses for vaulted ceilings, octagonal roofs with lantern, steel octagonal roofs, domed roofs, examples of steel domes, and vaulted conservatory roofs. The general character of the illustrations is the same as in the preceding chapter.

The roofs and trusses described in the 33 pages of Chapter VI. are those of coliseums, armories, train-sheds and exposition buildings. Most of these are actual examples selected from those previously published in engineering periodicals. The analyses of weights are given for the roofs of six armories and of one coliseum. Numerous references to articles in architectural and engineering periodicals are given in Chapters I. to VI., inclusive, where additional details of roof trusses are illustrated.

Chapter VII., consisting of 32 pages, contains data and methods for computing the purlin and truss loads and supporting forces or reactions, the methods being explained with the aid of 14 examples. Tables are given containing the weights of different roof coverings, rafters, ceilings, floors and trusses, and of allowances for snow and wind pressure. The examples show how to compute the roof and ceiling areas supported by truss joints of diagonal trusses, as well as of other trusses for roof crossings, hipped roofs and for other forms of roofs. The computations of truss reactions are given in complete detail for a number of cases for the benefit of draftsmen and builders who have not studied mechanics.

In the 47 pages of Chapter VIII., 30 numerical examples are given for the determinations of stresses in roof trusses of different types by the graphic method. Only simple trusses are used, some with inclined and others with horizontal upper chords. These examples are preceded by a brief but well-written explanation of some of the elementary principles of graphic statics and their application to the construction of stress diagrams. The author is to be commended for keeping the stress diagrams free from the mass of arrow heads which are sometimes placed upon them to find the character of the stresses, but which serve to complicate the diagrams and fail to give any adequate return for the labor involved.

Throughout the volume the contents show constant evidence of good judgment in the selection of material, while painstaking care is shown in the composition of the text. On the illustrations the dimensions are in all cases legible, and, with the exception of the lettering on a few of the smaller diagrams, the illustrations are well executed. There are 306 illustrations in all, including 11 half-tone views, or an average of more than one per page. While the book is intended primarily for architects, draftsmen and builders, it will be found by engineers to be worthy of addition to their library as a work of reference. The author deserves unstinted praise for the immense amount of labor involved in the preparation of this work, and it is to be regretted that it is his last contribution to the literature of his profession.

The publisher's note, following the preface, states that the volume constitutes only the first section of what Mr. Kidder intended to be a more complete and comprehensive work on roof trusses than had ever before been attempted. The second section was blocked out before his death, and is to be put "in hands familiar with Mr. Kidder's methods and competent to carry out the work along the lines he has already laid down."

Those who will read the sketch of Mr. Kidder's life, which is inserted after the table of contents, will understand why he was so well fitted to undertake the authorship of this book, as well as of the "Architects and Builders' Pocket Book" and several other volumes. He had taken the technical course in civil engineering, as well as that in architecture, became especially interested in the engineering and construction problems of architecture, and had an unusual experience in his professional practice. The portrait of Mr. Kidder appropriately forms the frontispiece, and an index is placed at the end to facilitate references to the text.

This volume is published as Part III. of the author's work on Building Construction and Superintendence, the titles of Parts I. and II. being Masons' Work and Carpenters' work, respectively. All these volumes would be more convenient to handle if they were not so heavy on account of using very wide margins and thick paper in which the fiber is loaded with earthy matter. Part III. weighs 2 lbs. 10½ ozs., which could be advantageously reduced at least 14 ozs.

DIE ABGEKUERZTE WETTERBESTAENDIGKEITS-PROBE DER NATUERLICHEN BAUSTEINE.—Mit besonderer Berücksichtigung der Sandsteine, namentlich der Wesersandsteine. By Prof. Heinrich Seipp. Frankfurt A. M.: Heinrich Keller. New York: Lemcke & Buechner. Paper; 6¾ × 10 ins.; pp. 140; 12 plates and eight text illustrations. $2.55 net.

Exposure tests, or life tests of materials which are required to resist weather influences, are among the most complex and uncertain of engineering tests. The long periods of time involved in weathering and the uncontrolled variation in the attacking forces makes it necessary for practical purposes to employ an artificial short time test for weathering qualities. In the case of paints the results of such "accelerated" tests can occasionally be checked by direct life test. With building stones this is far more difficult, as the periods of life involved are many times greater than with paint; the careful formulation of an accelerated test therefore becomes more important. Two specific tests are suggested by Prof. Seipp in the monograph above noted. The first is a test involving repeated freezing at definite temperature (the sample being first saturated with water), and measuring the loss of weight, loss of strength, etc. The second test bases on alternate exposure to carbon dioxide, oxygen and sulphur dioxide in the presence of water. A series of tests by these methods on some German sandstones, a diorite, a quartzite, and a sample of Carrara marble, is presented by the author. The great susceptibility of the marble to the chemical attack was well shown, confirming the results of experience with this material in exposed situations.

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Steam Turbines.

Reviewed by Storm Bull.*

STEAM TURBINES.—By Carl C. Thomas, Professor of Marine Engineering, Sibley College, Cornell University. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 5¾ × 9¼ ins.; pp. 287; folding and other plates, and many text illustrations. $3.50.

STEAM TURBINES.—Their Development, Styles of Build, Construction and Uses. By Wilhelm Gentsch. Translated from the German by Arthur R. Liddell. London, New York and Bombay: Longmans, Green & Co. Cloth; 7 × 10¼ ins.; pp. 375; 637 figures, mostly in the text, and four folding plates at end of book. $6, net.

With the growing importance of the steam turbine it is to be expected that the literature on the subject will increase rapidly. It is a matter for congratulation that a book like that by Professor Thomas has been produced in this country, as it is a thoroughly good one and is a distinct addition to the available literature on the subject—not that the book is such a one that it is without faults, but there is considerable originality in the treatment of various of its parts. It is very clearly written; it is of a practical nature, yet on a thoroughly scientific basis, and it is up to date.

The book is divided into ten chapters, of which the first six, comprising 150 pages, serve as an introduction to the study of the steam turbine. This may perhaps seem out of proportion, but evidently the author has been of the opinion that only in this way would he be able to get the proper foundation upon which to build. For this purpose a theory of the reaction of flowing fluids is given in the first chapter, accompanied by examples illustrating the action of steam upon turbine buckets. It is very possible that the author has gone too much into detail at this place, as no engineer should undertake the study of steam turbines unless he has already a thorough knowledge of both mechanics and hydraulics. The second chapter treats of The Thermodynamic Principles Involved in the Flow of Steam, and the third of Graphical Representation of Work Done in Heat Transformations. In this latter chapter a very satisfactory explanation of the temperature-entropy diagram, with numerous applications, is given. Calculation of Velocity and of Weight of Flow is the title of the fourth chapter, in which the application of the temperature-entropy diagram to the problem in question is further discussed. With the fifth chapter, treating of the Velocity as Affected by Frictional Resistances, the experimental field is entered, to begin with, however, only to show how such frictional resistances, as found by experiments, affect the curve of expansion, etc., as shown on the temperature-entropy diagram. The sixth chapter describes and gives the results of various experiments on the flow of steam through nozzles and through buckets. Not less than 58 pages are filled with the descriptions of the experiments, the results of the same and their discussion. It would seem that space might have been economized here without damage to the book. Some of the experiments, perhaps most of them, are very interesting and to the point; others, however, like those treating of the flow of steam through certain kinds of nozzles, the efficiency of which everybody knows is and must be very low, do not add to the usefulness of the book. The space saved might have been used with profit in the amplification of the last four chapters of the book, in which the real study of the steam turbine in taken up.

The so-called impulse turbine is treated in Chapter VII., and Chapter VIII. is devoted to what the author is pleased to call the Impulse and Reaction Turbine. The reviewer has already had occasion to express the opinion several times that the ordinary names, impulse and reaction turbines, are indeed very unfortunate, and he has insisted that all turbines made use of the reaction of flowing fluids, and that, consequently, all turbine wheels are reaction wheels. After carefully looking over Professor Thomas' book, the reviewer finds that the author means by "the impulse of fluid flowing in a channel, without change of pressure," exactly what the reviewer has been taught and still believes to be the reaction of a fluid flowing in a channel. It is very evident from the choice of names of the two classes of turbines that the author is of the opinion that it is only in what he calls the "impulse and reaction turbines" that the reaction is made use of; but the reviewer cannot but think that he is right when he states that the real difference between the two kinds of turbines is to be found in the fact that in one the pressure does not change during the passage of the steam through the turbine wheel proper, whereas it does in the other kind. Because of this belief the reviewer has proposed to call these two kinds of turbines velocity turbines and pressure turbines, as indicating by their names that in the first the steam acts only through its velocity, and in the second also through its pressure. However, the two chapters are otherwise very satisfactory, especially because of the numerical examples of computation of turbines contained in them.

Chapter X. treats of types of turbines and their operation. What there is of it is very good, the illustrations being especially good. But it would seem that a larger selection, including some types of European manufacture, would have added value to the book. It would also seem to be out of place to quote nine pages of results of experiments by the Westinghouse Machine Co. on their type of the Parsons turbine. The reviewer would certainly prefer to see results of tests made by disinterested parties.

The last chapter of the book discusses the marine steam turbine, and is perhaps especially valuable because of the numerical data regarding the use of steam turbines on sea, the efficiency of such turbines as compared with that of reciprocating engines, and the illustrations accompanying these discussions.

There are a great many misprints in the book, but the reviewer has been informed by the publishers that this is owing to the fact that the first edition had to be rushed in order to get it ready for use for one of the classes of the author at Cornell University. This fact shows that the book was gotten up principally for the purpose of serving as a text-book in technical colleges—a fact which is also very apparent to anybody studying the book. It will serve the purpose of a good, solid introduction to the subject of steam turbines, but the reader will find comparatively little as to what has been attempted or accomplished in this direction in the world as a whole. However, as a text-book it is quite satisfactory. The only other book in the English language with which it could be compared is that of Dr. Stodola, and although the book has a much wider scope than that of Professor Thomas, yet it is not very well adapted to serve as a text-book, especially in view of the fact that its translation has been done so very poorly. The reviewer is of the opinion that Professor Thomas' book will fill a want that has been felt by a great many technical educators, and that it will have a large sale that will be well deserved.

The German work by Gentsch, now made available in English, is of an essentially different character from that by Thomas, or, in fact, from any book on steam turbines that has yet appeared. The reviewer has been familiar with the German original since its appearance, somewhat more than a year ago, and he has found it a unique source of information as to what has been attempted in the various countries of the globe in the line of the invention and development of the steam turbine. The author, because of his intimate relations with the German Patent Office, has been in a position to thoroughly study the patent records of the various industrial nations, and he has so made use of this opportunity that the picture he presents of the efforts made along the line of the invention and development of the steam turbine is a very complete one. His descriptions are always accompanied with illustrations, so that the worker in this line will find an amount of material which it would be very difficult to get in any other way. Even a casual reader of the book cannot help getting the impression that an astonishing amount of energy and inventive effort has been expended in developing this the youngest of all heat motors. He will also find a large number of crude and misguided ideas carried out in various of the designs discussed in the book. But it is one of the merits of Mr. Gentsch's book that a student or worker in the line of steam turbine design will find in it not alone the successful designs, but also those ideas which practice and theory have shown to be worthless. The fact is that Mr. Gentsch not only describes the various inventions and designs, but also accompanies these descriptions with a very scorching criticism, although the language used is moderate.

To give an idea of the comprehensiveness of the book, the titles of its chapters ought to be given, but as these number 24, the space of an ordinary review would hardly suffice if an instructive commentary should be given for each one. The book is of such a comprehensive nature that there is hardly a feature of the modern steam turbine which does not find its adequate treatment. The book is, however, of a popular nature, so that it cannot take the place of such books as those of Dr. Stodola and of Professor Thomas. In fact, it is almost impossible to find a mathematical formula in the book, so that almost anybody interested in the subject of steam turbines will be able to understand it and profit by it.

One of the most interesting features of the book, at least to the reviewer, is the classification of steam turbines, which the author has carried out very fully. It is in this book that the names "pressure" and "velocity turbines" are found for the first time, and the reviewer is of the opinion that Mr. Gentsch's classification is a thoroughly logical one and that the names are very appropriate. However, as the author himself remarks in his preface, it is not to be expected that the classification of the individual types of turbines, as given in the book, should be found entirely correct in the future, because there is at the present time not enough accurate knowledge about the action of the steam in passing through the various guide and turbine wheels. A large amount of experimental data must be obtained before any definite conclusions can be drawn as to the class to which certain turbines belong.

It is hardly necessary to state that the translation of Mr. Gentsch's book is a very welcome addition to the technical literature in the English language. Taking it altogether, the translation has been very well done. It is true that the original is written very clearly, and consequently the work of translating it has been comparatively easy; nevertheless, a good translation is always something to be praised, as the examples of the opposite kind are very numerous. The reviewer has found some mistakes, but not of a very serious nature, and at other places a too literal translation has been attempted. But in a book covering some 370 very large pages it would be too much to expect to find no faults or errors.

Both print and paper in the translation are very good; however, not so good as in the original, which is exceptionally good in these respects. In comparing the illustrations (of which there are 637), it is also very evident that the paper in the original is of a better quality, at least for illustration, than that in the translation. However, comparing the latter with American books, there is no question but that it is fully up to the average. The price, $6 net, is also a very moderate one; it is, in fact, considerably lower than that charged for the average American book of the same size, and at the same time so profusely illustrated. Because of all of the above enumerated facts it is to be hoped that the book will find an extensive sale among American engineers.

GESCHICHTE DER GROESSTEN TECHNISCHEN ERFINDUNGEN.—By Franz Marie Feldhaus. Kötzschenbroda and Leipzig, Germany: H. F. Adolf Thalwitzer. Paper; 4 × 6 ins.; pp. 68; 13 figures in the text. Paper; 50 Pf.; cloth, 80 Pf. American price, 20 cts. and 32 cts., respectively.

A series of very brief historical notes on the early development of some of the most important inventions—the compass, fire-arms, printing, water wheels, wind mills, the steam engine, the railway, the velocipede, navigation, diving apparatus, aerial navigation. In several instances the notes are too sketchy to be of value.

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Refrigerating Machinery.

Reviewed by J. C. Bertsch, M. Am. Soc. M. E.*

MODERN REFRIGERATING MACHINERY.—Its Construction, Methods of Working and Industrial Applications. A Guide for Engineers and Owners of Refrigerating Plants. By Prof. Hans Lorenz, Ph. D., Principal of the Institute for Technical Physics, Göttingen University. Authorized Translation from the Third German Edition by Thomas H. Pope, B. Sc., Lecturer in the British School of Malting and Brewing, Birmingham University; with Chapters on American Practice in Refrigeration, Insulation, Auditorium and Other Cooling, by H. M. Haven, S. B., M. Am. Soc. M. E., and F. W. Dean, S. B., M. Am. Soc. M. E. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 5¾ × 9¼ ins.; pp. 396; tables, and 271 figures in the text. $4, net.

This book is based on "Neuere Kuehlmaschinen." Prof. Lorenz is one of the foremost writers on Artificial Refrigeration. His many contributions to the Journal of the Society of German Engineers (Zeitschrift des Vereins Deutscher Ingenieure) and to the German Journal of Refrigeration (Zeitschrift fuer die gesammte Kaelte Industrie) are considered authoritative.

With the first German edition of his work, which appeared in 1896, and which was translated in French in 1897, he made a great hit. The second German edition, revised and much enlarged, appeared in 1898, and the third edition in 1901. It is to be wondered that an English translation was not undertaken much sooner, as all German editions have been well received by the profession, and especially by the engineers and managers of refrigerating plants, for whom the book was expressly written. The success of this book must be attributed to the acknowledged competency of the author as well as to the fact that mathematical treatment is strictly eliminated. Of the large number of good books on artificial refrigeration, many are written under the presumption that the reader knows all the fundamental principles and is a master of mathematics. Consequently, such books are of no value to the "men in overalls," of whom only a few went through college. The authors of a second number of books on refrigeration do not consider it necessary to know the why's and wherefore's of certain subjects, but simply give an account of what has been accomplished in the construction of refrigerating machinery. But what is most needed on this subject is a book in the hands of the operating engineer which will enable him to learn and to understand the underlying principles and chemical and physical properties of the materials he has to handle, and which will give him all the information needed for the successful operation of the machinery and apparatus in his care. Such a book is the one before us.

The critics of the first German edition were surprised that an author who is engaged mostly in theoretical work could write a book of so much practical value. But in his second edition the author made the statement that in machine construction he is strictly against all that kind of theory which cannot be controlled or demonstrated by practical experiments, and that he, on the other hand, considers purely empirical rules not only very expensive and of no value, but most dangerous for an industry, the success of which depends entirely upon the knowledge of physical laws and methods. Working upon such a sound basis, the author combined in his work his mastery of theory with the results obtained in actual practice, and the product of his labors is indeed a compendium for the student as well as for the practical operator of refrigerating machinery. While the author limited himself to European conditions which came within his own experience, his work is, nevertheless, with the exception of the chapter on Ice-making, of much value to everyone interested in refrigerating machinery.

The book is systematically arranged in ten chapters, and the matter is treated in a clear and concise manner. Examples are used to demonstrate the application of the rules, and by this method, together with the great number of fine illustrations, even the inexperienced reader can find advice without waste of time. The metric system of weights and measures, as used in the German editions, is converted into the system customary in this country, so that no calculations are necessary.

Professor Lorenz first explains the principles of the theory of heat in such a plain manner that only careful reading is necessary to understand the subject fully. Treated without the use of mathematics, this chapter is very valuable to all those whose mathematics do not extend beyond elementary arithmetic only. In the second chapter the author treats of the different methods of producing cold, considering only the practical methods of the present time. The cold-vapor machines, which are exclusively used today, are divided in three groups, which are: The compression machines, handling either ammonia, carbon dioxide or sulphur dioxide; the absorption machines, handling ammonia exclusively, and the combined compression and absorption machines, also for ammonia only. After a brief description of these three groups, there follows a description of the chemical and physical properties of the most important refrigerants, the relative value and cold-producing power of each at different temperatures being set forth by tables and examples. Then follows a comparison of the energy required by the compression and absorption systems at different temperatures, and finally are shown the engines for driving the cooling machines, and the general arrangement of cooling plants.

Chapter III. is devoted to the construction of the compressors and their appurtenances. Only the horizontal double-acting compressors are considered, because every other type is excluded from the European practice. The "Linde" type of compressors dominate, and every detail of valves, stuffing boxes, regulators, traps and separators is described and illustrated. The carbon dioxide, commonly called "carbonic acid," compressors of different make are fully treated, also the sulphur dioxide, or "Pictet" compressor. A description of the method of testing compressors with the indicator concludes this chapter. After showing what the provisions for connecting an indicator to the compressor should be, the many faults of a compressor as found by the indicator are explained by indicator cards, and the computation of required horse-powers is shown by examples.

Chapter IV. deals with the apparatus giving out and taking up heat. After describing the action of the condensers in general, and the influences of saturated and dry air, the submerged and atmospheric condensers are shown in detail. Then are explained the different types of cooling towers and evaporators, and finally the coolers and brine tanks with fittings and connections are described.

The absorption system is briefly described, and practical directions for its operation are given in Chapter V. With Chapter VI. begins the description of actual refrigeration. The different methods and apparatus for cooling liquids are first treated. The cooling of water, brine, milk and beer is explained by practical examples, and among the illustrations the careful observer will find the origin of some American patents for constructions used and published for many years in Europe.

Chapter VII. is also important, as it explains the laws of air-cooling, taking into consideration the humidity and natural or artificial circulation of the air. For different purposes the direct and indirect cooling systems, as well as the tube-coolers and wet surface and spray-coolers, are compared. Much practical advice is also given with reference to the proper selection of insulating material. This chapter is concluded with calculations for the cold required for air-cooling, taking into account all the losses by ventilation, doors and windows, illumination, and persons engaged within the rooms to be cooled.

Chapter VIII. is devoted to the manufacture of ice, to freezing processes for mining operations, and to artificial skating rinks. The European method of making ice by the can system differs from the American method so greatly that a practical application can not be made, and outside of gaining knowledge of the construction of ice plants abroad, little benefit can be derived from this part. The manufacture of ice on board ship is interesting, but the treatment of the manufacture of plate-ice is of no benefit whatever. The author states that this system of ice-making is seldom carried out in Europe, and the references on this subject are even misleading, inasmuch as it is stated that the plate-ice contains "all the impurities of the water, in particular, is rendered turbid by a large number of small air bubbles." The American practice proves just the contrary, as the clearest and purest crystal ice is made in this country by the plate system.

The distillation of water for ice-making is practically not treated at all, the only reference to this subject being the mention of a multiple evaporator without the use of a vacuum, which is altogether impracticable for our conditions. The freezing process, as applied to shaft-sinking, known as the "Poetsch process," is the only described, and the practical application fully explained by a calculation of freezing the ground for a shaft 15 ft. in diameter and 150 ft. deep. The 1½ pages devoted to an artificial skating rink give no more than a mere idea of what a skating rink consists of.

Chapter IX. is devoted to the production and application of cold at very low temperatures, or primarily to the liquefaction of air. While this subject is of little practical value to those seeking advice in practical refrigeration, it is very interesting, and marks the climax in the art of producing cold. First are described the early attempts of Pictet, Olszewski, and Dewar to liquefy difficultly condensable gases for the production of temperatures as low as — 300°, which were needed for the preparation of some chemically pure substances. Pictet's sulphur dioxide process for the liquefaction of oxygen is fully explained. Then follows Olszewski's and Dewar's ethylene process for the same purpose, giving account of the efficiency of both methods, and the energy required for the production of one pound of liquid oxygen. Finally Prof. Linde's process and apparatus for liquefying atmospheric air is described and illustrated in its several stages. It is very interesting to learn of this process, by which no cooling agent other than cold water for absorbing the heat of compression is used, and which is based solely on deviations from the laws of Mariotte and Gay-Lussac. Besides the importance of the Linde process for the separation of the two constituents of the air by mechanical means, the reasons why such liquefied gases cannot find an industrial application are also explained, and after a careful study of this subject one can easily understand why the so-much-talked-of Tripler's air bubbles had to burst.

With the concluding chapter the author had to set aside his aim to treat the subject without the use of mathematics, and he therefore hopes only that this chapter may be welcome to some of the readers. The subject, "Determination of the Yield of Cooling Machines," is of special value to refrigerating experts and builders of cooling machines. With the continually increasing competition this machinery is sold under certain guarantees with reference to the yield and economy of a complete installation. As these guarantees, especially for large plants, often contain very precise stipulations as to efficiency, fuel consumption, etc., a more precise test of the apparatus than was formerly employed is necessary. This chapter begins with an explanation of why the measuring of the work done by the refrigerating machine by means of the ice-production is the most inaccurate of all methods. But as these means have always been considered as the safest, the author points out that by this method a great amount of cold actually produced is never accounted for, and where it is attempted, it is but mere guess work. To take care of all conditions, and to guard against possible errors, special cooling methods for ascertaining the correct yield of cooling machines are described. Then follows the determination of the cooling effect at constant temperatures, which is explained by examples, after which is given a description of the calorimetric investigation under stable conditions.

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Special devices for measuring and regulating the flow of cooling water and cooled brine are illustrated, and their application explained. As all of these calculations form mathematical problems, of which the practical operators of this class of machinery know but very little, this chapter is of little value to them.

Considering the work as a whole, Prof. Lorenz has made good his promise to furnish a description of the latest European practice, which he has done without favoring one or the other systems of machinery, but simply stating what improvements have been made in Germany, France and England, giving also his own opinion on each subject.

A different method has been followed by H. M. Haven and F. W. Dean, the authors of "American Practice in Refrigeration," which forms an appendix of eight chapters to the work of Prof. Lorenz. From the title, as well as the preface, a brief description of the salient features of refrigerating practice in the country would be expected. But one is badly disappointed by finding arrangements described which are entirely out of date, and by missing many subjects which are truly salient features of the latest American practice. Chapter I. explains the different methods of refrigeration in a concise manner, but the illustrations used show plainly that the authors favor a certain combination of apparatus, which is a vertical machine and a condenser with bottom inlet and a form of liquid outlet, which even the originators abandoned some time ago. The reviewer is of the opinion that the writer of a book which is designed to be of benefit to all interested parties should be impartial in the selection of the matter, lest his work become a mere catalogue. This holds good for the description as well as for the illustration of a subject, and more so with reference to systematic diagrams. The condenser shown in the five diagrams of Chapter I. is a has-been construction, and if the compressor shown in these diagrams represents the American practice a glance at the records would inform the authors that the latest practice favors the horizontal machines.

Chapter II. is devoted to the refrigeration of compartments, giving the temperatures needed for different purposes, warehouse capacities, piping and refrigeration required, and results of government investigations with reference to the preservation of perishable goods. This chapter gives many practical data on each subject treated.

Chapter III. deals with the insulation of rooms, explaining first the general principles of construction, and then showing different types of insulation as employed in actual practice. Next is treated the design of insulations, beginning with a table of the heat conductivity of many materials, according to the experiments of Peclet, and a table of types of insulations by John Starr. For the design the authors adopted the German method for obtaining the heat loss through various types of construction, as given by Prof. J. H. Kinealy in his book, "Formulas and Tables for Heating." This method cannot be criticised as far as thoroughness is concerned, but it is too complicated for ready reference, and the equations employed forbid use by the practical engineer. C. P. Paulding's "The Transmission of Heat Through Cold Storage Insulation" gives a much shorter method for the design of insulations, and the examples there illustrating the application of the formulas make the matter clear to those who cannot handle mathematics.

Chapter IV. treats can ice-making in a rather incomplete manner, and is altogether too short to be of any value. Ice-making is the larger part of the refrigerating business in this country, and while the authors have furnished some data on piping, refrigeration, temperatures and time required for the cooling of compartments, nearly nothing is given for ice-making. The description of the can-ice system consists of a few general remarks and a list of the standard sizes of ice cans. Chloride of calcium brine is named as the freezing solution "usually" employed, whereas the general practice is the use of chloride of sodium (common salt). This solution, the authors state, may be cooled either by direct expansion, or brine coils, in spite of the fact that brine coils are never used. The purification of the water for can-ice making is also dismissed with a few remarks only, and no constructions or data on distilling apparatus are given. The chapter is concluded by a description and illustration of the "Lillie" vacuum evaporator for obtaining the highest economy in distillation.

Chapter V., with a little over one page of reading matter, covers the plate-ice system in even more general terms than the can system. No dimensions, proportions or any other data are given, and the illustration of "a typical American plate-ice tank" shows the brine system of the late David Smith, which system was one of the earliest attempts in plate-ice making, and has been discarded about fifteen years ago as unsuccessful. Reference is made to the economy of a more recent system, without giving any construction data, or even the name of the builders, which is the Carbondale Machine Co. As the development of the plate-ice system is wholly American, and of the greatest interest to ice manufacturers, it is to be regretted that the authors seem to know nothing about the details of construction and proportions of plate-ice plants, as well as of the different plate-and-block systems in actual practice for a number of years, and of which the Rassbach system, as installed in great number by the Vilter Mfg. Co., of Milwaukee, Wis., is one of the latest.

Chapter VI. is devoted to the description of refrigerating machines, and begins with explaining the unit of refrigeration, which is given as the equivalent of 284,000 heat units, instead of 288,000 B. T. U., the now adopted and correct figure. The description of the several types of compression machines consists merely of cuts from the catalogues of the York Mfg. Co., Frick Co., Fred W. Wolf Co. and De La Vergne Machine Co. The absorption machines are represented by illustrating the system of the Carbondale Machine Co., which is called "the typical American absorption machine." The "Stratton" and "Vogt" systems are not mentioned, in spite of the fact that the greater number of absorption machines in use are built on these systems.

The ammonia condensers are summarily dealt with by stating that the atmospheric, double pipe, enclosed and submerged types are in use, of which the first three are illustrated by cuts from catalogues. Nothing is mentioned about the sizes and relative merits and efficiencies. The same is the case with brine coolers, of which the shell type and double pipe type are illustrated. This chapter is concluded by remarks on "pipe joints, flanges, valves and accessories." The authors state: "There are practically only two suitable types of pipe joints for ammonia, the gland and the De La Vergne types." From this it would seem that the authors either do not know anything but De La Vergne types, or wilfully attempt to misrepresent the American practice, which includes the time-honored Boyle Union, the Litharge and glycerine joints, the Wolf, Vilter, Arctic and Hercules types of pipe joints, each of which has stood the test for years as being just as good as the De La Vergne type. The same can be said of the expansion valves, relief valves, oil traps, separators and liquid receivers, of which the authors give no information.

Chapter VII. is devoted to "Air Cooling"; but as the different systems are simply enumerated and no further data given, no benefit can be derived from its contents. The refrigeration required for cooling auditoriums and chocolate factories is estimated, and, "owing to the lack of experimental data," all conditions are assumed, which, of course, excludes the results from being called "practice."

Chapter VIII. deals with special applications of refrigeration. Pipe line refrigeration, fish freezing, water cooling, marine and hotel refrigeration, and other applications are passed with general remarks, without giving any data concerning American practice. The only item of practical value is the "Drying of Air for Blast Furnaces," which is taken from a paper by Mr. James Gayley, and which gives the results obtained by practical tests made at the Isabella furnaces of the Carnegie Steel Co. If all subjects had been treated likewise, the author's work would certainly be welcome as the "American Practice of Refrigeration," but in the present shape it is at a great variance with its title. An appendix contains the tables usually found in the catalogues of the ice machine builders.

The publishers have done their duty by giving the book a handsome appearance, and it is to be hoped that in future editions the "American Practice of Refrigeration" will be brought much nearer to the characteristics of Prof. Lorenz's work, which are impartiality and copiousness of practical information.

METHODES ECONOMIQUES DE COMBUSTION DANS LES CHAUDIERES A VAPEUR.—By J. Izart. Paris, France: H. Dunod et E. Pinat (49, Quai des Grands-Augustins). Paper; 6½ × 9¾ ins.; pp. 213; text illustrations and tables. 7 fr. 50; American price, $2.25.

The author aims to present a descriptive and didactic survey of the whole subject of combustion in boiler furnaces. More specifically, his theme is Operation of Boiler Furnaces, introduced by a discussion of the phenomena of combustion and heat losses in boiler furnaces. Excluding all matters relating to furnace construction and the working of boilers, the text presents all other considerations which affect fuel economy in the boiler plant. This includes notes on the selection, storage and handling of fuel; on firing, with principal regard to automatic stokers; on regulation of air supply; on recovery of waste heat by superheaters, economizers, preheating of the air, etc.; and on continuous control of the fire-room, by metering water, steam and coal, recording draft and temperatures, observing density of smoke, and analyzing the chimney gases. A valuable series of tables, some 55 in number, is appended.

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Electrical Books.

Reviewed by H. H. Norris.*

STANDARD TELEPHONE WIRING.—For Common Battery and Magneto Systems. A Hand-Book for Telephone Men, Containing Diagrams of Circuits for Straight Lines, Party Lines, Plans, Sub-Stations, Private Lines and Intercommunicating Systems, with a Brief Description of the Apparatus Used and Rules of the Fire Underwriters. By James F. Fairman. New York: McGraw Publishing Co. Leather; 4½ × 7 ins.; pp. 91; 74 figures in the text. $1, net.

THE WIRING HAND-BOOK.—With Complete Labor-Saving Tables and Digest of Underwriters' Rules. By Cecil P. Poole, M. Am. Inst. E. E. New York: McGraw Publishing Co. Leather; 4½ × 8¼ ins.; pp. 85; 61 figures, mostly in the text, and 32 tables. $1, net.

THE MANAGEMENT OF ACCUMULATORS.—A Practical Handbook. By Sir David Salomons, Bart., M. A., Assoc. Inst. C. E., M. Am. Inst. E. E., etc. Ninth Edition, Revised. An Edition mostly rewritten, of Volume I. of "Electric Light Installations and the Management of Accumulators." New York: D. Van Nostrand & Co. London: Whittaker & Co. Cloth; 5 × 7½ ins.; pp. 174; 38 illustrations, partly in the text. $2.50, net.

ALTERNATING CURRENTS.—Their Theory, Generation and Transformation. By Alfred Hay, D. Sc., M. I. E. E. New York: D. Van Nostrand Co. Cloth: 5½ × 8¼ ins.; pp. 291; 178 figures in the text. $2.50, net.

ELECTRICITY METERS.—A Treatise on the General Principles, Construction and Testing of Continuous Current and Alternating Current Meters, for the Use of Electrical Engineers and Students. By Henry G. Solomon, Assoc. M. Inst. E. E. London: Charles Griffin & Co., Ltd. Philadelphia: J. B. Lippincott Co. Cloth; 6¼ × 9¼ ins.; pp. 323; 307 figures in the text. $5, net.

Mr. Fairman's book contains a large number of diagrams for installing and connecting all kinds of telephone circuits. The book is intended primarily for telephone wiremen, and it appears to be well adapted to their work. The diagrams do not cover central station wiring, but merely that at the subscribers' stations. A short introduction contains elementary information regarding the construction of the several pieces of apparatus which comprise a subscriber's outfit, and this is followed by a short description of line work and wiring requirements. Then follow numerous diagrams which cover a large variety of subscribers' circuits, including both the common battery and the magneto systems. The book closes with an abstract from the Fire Underwriters' rules pertaining to telephone installations.

Mr. Poole has arranged in convenient form a number of useful diagrams and tables to facilitate the work of installing wires for electric light and motor service. A certain amount of elementary instruction concerning the laying out of circuits and the determination of the proper sizes of wire forms the introduction to the book. The intention has been to facilitate the actual work of calculation by the introduction of graphical plans and tabular arrangements of data. The author clearly points out the difference between alternating and direct current wiring, and includes formulae for calculating the pressure drop in all cases. These formulae are not explained, for the reason that to a person not familiar with the theory such explanation would be useless, while to anyone already acquainted with the theory it would be superfluous. A large variety of diagrams cover all kinds of connection for transformers, motors and meters.

An appendix contains a digest of the Underwriters' rules regarding inside wiring, and another contains a collection of many useful formulae. One of the most valuable features of the book is a collection of 32 tables, printed on folding sheets of tough paper. By the use of these a great deal of tedious calculation may be saved.

SALOMON'S MANAGEMENT OF ACCUMULATORS.

Although extremely simple in mechanical construction, the electric accumulator, or storage battery, requires the most careful handling in order that injurious chemical reactions between the plates and the acid may not take place. The rate of charging and of discharging must be regulated in such a way that the desired chemical changes may be brought about by the current without unnecessary waste of energy; that is, with greatest possible efficiency. Storage batteries form a most important adjunct to lighting and railway power-plants, and they are also used in large numbers for many smaller but important applications. It is therefore highly desirable that the users of these batteries have at hand a clear and condensed treatise covering the principles involved in properly caring for them. Such a book is this recent one, by a most eminent authority on the subject.

The plan of the book is entirely practical, only the most elementary chemical theory being introduced. At the same time the reasons for the various statements are given, so that the instructions are more than mere rules, and the book is very readable, even to persons not directly interested in the subject. The introduction treats briefly of the important features of an electric lighting plant, in order to place before the non-technical reader one of the important fields of storage battery application. In England this is its most important field, the electric railway being a comparatively recent development. Following the introduction, a valuable chapter contains descriptions and illustrations of a number of English, German and American cells, including central station, automobile and portable types. The remainder of the book is devoted to working instructions for installing and operating storage batteries.

The matter of setting up cells is properly considered important enough to occupy an entire chapter. If the directions here given are closely followed, the battery will be prepared for charging without danger of injury. Two chapters are given to the operation of the battery, the one on charging being very complete and instructive. The closing chapters deal with battery troubles and testing; they contain many practical remarks based upon actual experience.

The book is to be commended to all users of storage batteries of any form. It is unconventional in style, but accurate in statement, and it is well indexed for ready reference.

HAY'S ALTERNATING CURRENTS.

The theory of operation of alternating current machinery and circuits is one which is difficult to treat clearly and briefly. Such a treatment should be practical, and at the same time it must be correct from the physical and mathematical standpoints. A number of excellent books upon the subject have already appeared, but there is still room for more. Development in the application of alternating currents is the order of the day, and books must be constantly rewritten if they are to be kept in touch with modern progress. The available books on the subject may be divided into two general classes—those treating of the theory and those dealing with actual machines. In some cases the subject is viewed from both standpoints, and that is true of the very excellent book by Mr. Hay, although he gives very little actual description of machines. The book is not systematically arranged, but by means of the complete index, table of contents and list of illustrations it is easy to locate any particular subdivision of the subject.

The profitable reading of the book requires a familiarity with the various machines and other devices treated. The reader must also have a good working knowledge of elementary mathematics through the calculus. The latter, while not absolutely necessary in following the discussion, is used several times, and it will facilitate the understanding of the text if the reader has at least a slight knowledge of both differential and integral calculus. From these statements it is evident that the book is apt to prove useful to the practitioner who wishes to refer to the principles underlying the performance of machines, and it would serve as an excellent text-book to accompany any advanced laboratory and lecture courses in electrical engineering.

The first three chapters contain the introduction to alternating current theory. In this section the laws of the flow of alternating currents through inductive, capacity and resistance circuits are given clearly and with the aid of algebraic and graphical illustrations. Various connections of impedances in parallel and series are discussed and analytical problems are solved to show the application of the laws. The production of a rotating field is described [illegible] its applications are briefly indicated. This [illegible]tion contains valuable material, and while [illegible] is nothing original in the treatment, it [illegible]ars to be ample for the purposes of the [illegible] already familiar with the subject. Two ch[illegible]s are devoted to a study of the measure[illegible] of alternating current, pressure, power [illegible] energy. This naturally involves descriptio[illegible] various alternating current instruments, a[illegible]y means of simple diagrams the construction [illegible] such instruments is exhibited. The rema[illegible] of the book, comprising about two-thirds [illegible]oken up with the operation of various kinds [illegible] alternating current machinery.

In studying the performance of [illegible]ternating current machines there are two m[illegible]ds which may be employed—one which sta[illegible] with the actual performance of the machines, which performance is analyzed by algebraic and graphical methods; the other, having for its b[illegible] the design data, from which the performance is predicted. It is difficult to determine which of these forms the motive of the present book, but in general it may be said that the author endeavors to explain the performance of the machines by reference to the theory. At the same time he indicates how the performance may be predicted when certain data are known. Take, for example, his treatment of the alternating current generator. He first explains in what respects the alternator differs from the direct current generator, presuming on the part of the reader an accurate knowledge of the latter machine.

READY AT LAST

ENGINEERING WORK IN TOWNS AND SMALL CITIES

By ERNEST McCULLOUGH, M.W.S.E.

Consulting Civil Engineer, Chicago; formerly Consulting Engineer, Merchants' Association, San Francisco; lately Engineer, Municipal Eng. and Cont. Co., Chicago, etc.

Author of "The Vrooman Act"; "Municipal Public Works"; "The Business of Contracting," etc.

We advertised this book last year but the author has busied himself rewriting it and his ideas grew until he made it a complete manual of Municipal Engineering for towns and small cities. Engineers in places of less than 20,000 will come to regard it as being as necessary as Trautwine.

It contains over twenty-five valuable full page tables and diagrams, with many drawings of details of things needed in street and sewer work, etc. It contains a chapter on specifications for street, sewer and water-works construction, with many valuable hints and practical kinks.

It has two chapters on how to preserve maps, notes and plans; how to index them, how to furnish certificates of surveys, etc., and instructions for a model system. It has a chapter on field work, and of these three chapters one engineer writes, who has read the MSS.: "I would have given many dollars when I started in business for just such information and hints. These chapters are as valuable to engineers in private practice as to city engineers." The author says that he has borne in mind the fact that the majority of city engineers in small places are in private practice. There is a valuable chapter also on Engineering Data, which will enable the man in the small place to do much of the designing that falls to the lot of the City Engineer.

When the book was started it was to be principally a general discussion with a few facts for engineers. We advertised a paper-bound edition and we advertised for $1.25 a cloth-bound edition. The book is twice as large as we anticipated and the paper-bound copies are withdrawn. No more orders for them will be accepted.

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*Professor of Electrical Engineering, Cornell University, Ithaca, N. Y.

The standard type of alternator is described and illustrated in some detail, with sketches showing some of the many variations in construction. The turbo-alternator is also briefly mentioned. Then follows a short description of alternator armature windings. Immediately following this are a number of sections dealing with the calculation of the e. m. f. and the effect of armature reaction is clearly explained. Later in the book a chapter on alternator performance describes the methods for predetermining the variation of e. m. f. with current of varying power factors. A similar treatment of transformers and induction motors follows the alternator chapter. The best parts of the book are those which deal with the performance of an alternator as a synchronous motor, with the induction motor and with the rotary converter. Such topics as the theory of single-phase induction motors, the voltage ratio and heating of rotary converters and the performance of polyphase induction motors are given in great detail and in a very satisfactory manner. The treatment is geometrical throughout; that is to say, the formulae are built up from the trigonometrical relations of the vectors representing the various alternating quantities. The algebraic method now commonly employed in this country is not used anywhere in the book. In connection with the theoretical descriptions, the author gives directions for performing the necessary experiments to test the value of the theory, and a number of performance curves are introduced at the proper points to show the results produced both by the application of the theory and by experiments.

At the close of the book two chapters deal with the latest types of alternating current generators and motors. This section is of considerable interest at the present time, on account of the tendency to employ alternating current motors for traction and other purposes. Most of the machines described here are at the present time mainly of academic interest, but it would be unsafe to say that any one of these will not find commercial application.

Viewing the book as a whole, it should be said that it will be discouraging to any general reader who is not thoroughly familiar with the subject, both from practical and theoretical experience. While the arrangement is somewhat logical, it is not systematic enough to make easy reading. Under the direction of a competent instructor, with proper laboratory facilities available, the book can be used as a text with excellent satisfaction. It is undoubtedly one of the best books on the subject of alternating currents, and as a reference book for students, manufacturers and users of alternating current machinery it will prove exceedingly valuable. It occupies the same field as such books as Steinmetz's "Alternating Current Phenomena," "Smith's "Practical Alternating Currents," "Bedell and Crehore's "Alternating Currents," and Franklin and Williamson's "Alternating Currents," but it differs from all of these in several particulars, so that it supplements them all. The book is well indexed, and the sections are set off by heavy-faced titles which easily catch the eye as the pages are turned over.

SOLOMON'S ELECTRICITY METERS.

It will probably surprise the general reader to learn how many types of meter are in use for the purpose of determining the amount of electrical energy used by a consumer. Here is a large book which deals only with energy or quantity meters, containing descriptions of a very large number of radically different types. The scope of the book does not include instruments for measuring current, electromotive force or power, of which the market affords a bewildering variety. The fields of application of the two general classes of instruments, however, are quite different. Electricity meters are used largely for commercial purposes; that is, for determining the proper charges to be made for electric service. The other meters, either of the indicating or recording type, are employed in scientific work, in the testing of electric circuits and machines, in power stations to insure proper operation of machines, and in standardizing or calibrating the electricity meters. The latter in this country are ordinarily referred to as watt-hour meters, ampere-hour meters and integrating watt-meters. The importance of the general subject of electricity meters may be inferred from the fact that the value of the electrical energy sold in this country each year amounts to over $100,000,000 for lighting alone. As this is practically all sold by meter and in small quantities, the reliability and accuracy of the meters used must be such as to insure justice both to the producer and to the consumer of the energy. The meters are also largely used in power plants to enable the owners to determine the daily, monthly and annual energy output, so that by comparing the output with the expense of operation the cost of generating a unit of energy may be calculated. It is safe to say that the number of electricity meters in use must be counted by the hundreds of thousands. The presence of this important market explains the reason for the activity of inventors and manufacturers in producing so many types of meter.

Mr. Solomon has in his book on electricity meters produced a work which will be useful to every one who buys or sells electrical energy. It contains both the theory and the practice of the subject, and it is well illustrated with diagrams and pictures of the meters. It is quite up to date and includes both European and American practice. Moreover, it is systematic and logical in arrangement. Three chapters are occupied with an introduction to the descriptions, and these include a classification of meters and a discussion of the characteristics of satisfactory instruments. The principles of operation of several types are given and the mathematical theory is worked out thoroughly. The calculus is freely used in these and later chapters, but this should not discourage the non-mathematical reader, who will be able to follow the descriptive matter without reference to the theory, although the ideal use of the book is to combine the two. The bulk of the book is filled with excellent matter describing all kinds of direct and alternating current meters, including motor and pendulum types. Considerable attention is given to the measurement of polyphase current power and energy, and special meter applications, such as the measurement of storage battery charge and discharge, are carefully considered.

Among the most interesting and timely chapters are those dealing with meters designed to insure equitable charges for service and to allow prepayment for energy. Maximum demand meters are used to permit the charging of a rate based upon the maximum current drawn by the consumer, who pays less if he draws a uniform current than if his demand is fluctuating. Recent developments in prepayment meters now make the use of such devices entirely practicable, and by their use much bookkeeping and other clerical expense is saved the supply company. These types receive ample treatment in the book, and, although some of the devices have been placed upon the market within a few months, these are fully described and illustrated.

The book closes with a couple of chapters on meter design and testing, which are among the best in the book. An ample index and a very complete table of contents greatly facilitate the use of the volume for reference. While written in England, it is none the less valuable for American readers, as modern practice in this country is carefully described.

HOUSE HINTS.—A practical treatise describing every essential detail pertaining to site, location, arrangements, construction, plastering, heating, plumbing, lighting, decorating and furnishing of the house. By C. E. Schermerhorn. Second Edition. Philadelphia, Pa.: House Hints Publishing Co. Paper; 6 × 9 ins.; pp. 55. 50 cts.

Almost every conceivable detail of house construction and furnishing is touched upon in this pamphlet. The remarks on each topic are necessarily brief, considering the space available, but they are extended enough to afford many useful hints. Following the main text is an alphabetical directory, by subjects, of manufacturers of and dealers in building materials and equipment, but only one manufacturer is given under each head.

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The Marine Screw Propeller.

Reviewed by D. W. Taylor.*

DIE SCHIFFSSCHRAUBE.—By Albert Achenbach, Principal of the Royal Naval Academy at Kiel. Part I. Its Development and Graphical Representation. Kiel, Germany: Robert Cordes. Cloth; 6½ × 9½ ins.; pp. 84; 25 plates and two folding tables. 10 marks; American price, $4.

This is the first volume of a three-volume work on the marine screw propeller. It covers the historical development of the screw, the graphic representation of screw propellers and some special types of screws of German invention. The author proposes in the second volume to take up matters of construction, and in the third volume the theory and design of screws.

In the volume now in hand the author, after a brief chapter of basic geometry and definitions, presents very briefly the historical development of the screw. This sketch is substantially a condensation of the historical portion of John Bourne's classical work of 1852, "A Treatise on the Screw Propeller." The author follows Bourne in ascribing to Ericsson and Smith the credit for the introduction of the screw into practical use. Smith was an English farmer, but was fortunate enough to secure the backing of an English banker. His patent for a clumsy one-bladed screw of a complete convolution was taken out in England on May 31, 1836, antedating thus by a few weeks, only, the patent granted Ericsson on July 13, 1836, for a screw propeller consisting of a number of blades set around a short cylinder. The design of the trained Swedish engineer was mechanically far superior to that of the English farmer, but the latter succeeded in enlisting the support of the English Admiralty where the Swede failed. Ericsson, however, succeeded in obtaining the support of the Americans Ogden and Stockton and came to America, where, as well as in France, his type of screw was soon generally accepted. The Smith screw still had preference in England, although the clumsy first design was soon improved upon as a result of practical experience. It is recorded that the first man-of-war fitted by Smith had a one-bladed screw forming a complete helicoidal convolution. Early in its life the vessel, through grounding, broke off about half of the screw surface, with the result of an immediate gain in speed and a prompt improvement in subsequent Smith screws. It is to be regretted that Herr Achenbach, who gives in his historical chapter some space to freak screws of early days, taken from Bourne, has entirely ignored the work of the Americans, Bushnell and Stevens. Bourne himself does but scant justice to these pioneers. When Bushnell in 1776 built a submarine boat, navigated and propelled by one man, he fitted it with rude screw propellers for propulsion and for forcing it up and down in the water. Bushnell, in October, 1787, described to Thomas Jefferson his appliance as follows:

> An oar formed upon the principle of the screw was fixed in the fore part of the vessel; its axis entered the vessel, and being turned one way rowed the vessel forward, but being turned the other way rowed it backward. It was made to be turned by the hand or foot.

While Bushnell's submarine boat did not accomplish its purpose of destroying the English men-of-war, there is no doubt that it did move with its one-man power, and it seems that the American patriot was the pioneer in actual marine propulsion by the screw.

The work of John Stevens, of Hoboken, was notable, and should not be ignored in any history of screw propulsion, however brief. Stevens, in 1804, more than thirty years before Smith and Ericsson, built a small boat fitted with boiler, engine and twin screws of his own design. The screws were four-bladed, closely resembling modern types of screws, as may be seen by anyone who cares to examine them in the National Museum in Washington, where they are preserved. The boiler appears to have been unsuccessful, but it was demonstrated that the apparatus would drive the boat for short distances at 7 or 8 miles per hour. The Stevens screw, however, was before its time. The engines of the day were poorly adapted to screw propulsion, and Stevens turned his attention with great success to the construction of paddle vessels, although it appears that he continued to advocate the screw propeller. While no one will begrudge the credit to which Smith and Ericsson are entitled for the commercially successful application of the screw, there is no doubt that John Stevens made the first *mechanically* successful application in connection with steam propulsion.

Leaving historical matters, Herr Achenbach devotes the greater portion of the present volume to the descriptive geometry of the screw and the various approximate methods of developing into a plane surface the undevelopable helicoidal screw surface. The methods of representing graphically screws of all kinds of variable pitch, and with inclined and curved generatrices, are given and explained. This portion of the book is excellent. The treatment is adequate, clear and concise, and accompanied by an ample number of figures. For developing a screw surface the author appears to prefer a method taken from Barnaby, although he gives several other methods. Barnaby cuts the screw surface to be developed by a cylindrical surface co-axial with the axis of the screw. This cylindrical surface cuts the screw surface in a helix which is projected to the rear as a circle. Barnaby cuts the cylinder by a plane osculatory to the helical surface at the center of the blade. This cuts the cylinder in an ellipse which has the same circular rearward projection as the helix cut from the screw surface. The elliptical arc corresponding to the helix is then swung about a line perpendicular to the axis into a plane perpendicular to the axis, and repeating this for a number of points the developed screw profile can be plotted. Barnaby's method is perhaps the most accurate of the approximate methods, but somewhat more complicated in application than others equally good for practical purposes.

The closing chapter of the volume applies the methods developed in the preceding portion of the book to the delineation and description of two types of German patent propellers, the Zeise propeller and the Niki propeller. The latter is the invention of his Royal Highness the Grand Duke Frederick August von Oldenburg. The essential feature of the royal invention is the separation axially of the several propeller blades, one blade of a three-bladed propeller, for instance, being located on the hub forward of the usual position, and one blade aft of the usual position. The inventor proposes thus to secure greater distance between the blades in operation, with consequent diminution of interference and less tendency to cavitation. It would seem doubtful, however, whether this result could be obtained. Thus, in a three-bladed propeller of 18-ft. pitch the slices of water between the successive blades when in operation would be in round figures, neglecting slip, each 6 ft. thick axially. If one blade is set a foot forward of its normal position and one a foot aft, the same slices would be in succession 7 ft., 7 ft., and 4 ft. thick axially. Whatever the blades have gained as regards two slices would be lost on the third. The essential features of the Zeise propeller appear to be, according to the author, a pitch decreasing radially, a rather narrow blade and skillful design. As regards mechanical features, the author gives no very convincing reason for his very warm praise of the patent Zeise and Niki propellers. He gives a table furnished by the Zeise Company showing comparative results on a yacht tried with a Zeise propeller, a Niki propeller, another patent propeller and a propeller of the usual type. As compared with the trials with the usual type of propeller, the trial with the Zeise propeller gave an increase of speed from 12.86 knots to 13.92 knots, and the trial with the first Niki propeller gave an increase from 12.86 knots to 14.06 knots. These are notable gains, which the author in his text ascribes entirely to the propellers. The data given in the table are not sufficient for critical analysis of the figures, the dimensions and displacement of the yacht, for instance, not being stated; but it is stated in the table that when tried with the propeller of ordinary type the mean draft of the vessel was 12 ft. and the horse-power developed 801. With the Zeise propeller the mean draft was 11 ft. 3 ins. and the horse-power 1,097. With the Niki propeller the mean draft was 11 ft. 3½ ins. and the horse-power developed 1,116. It appears, then, on the face of the table, that the increase of something over 8% of speed with the Zeise propeller and 9% with the Niki propeller was coincident with a decrease of trial draft of about 6% and an increase of horse-power of about 37% for the Zeise propeller and nearly 40% for the Niki propeller. These facts indicate clearly that the gain in speed was not due entirely to meritorious features of the patent propellers and might, indeed, be more than accounted for by the decreased trial displacement and the increased trial power, although, as already stated, the data are inadequate for critical analysis.

There is an obvious typographical error in Table II., the indicated horse-power of the starboard engine being given for the usual type of propeller as 711, when 411 is intended. There is also a curious feature in the statement of draft for the trial with the ordinary type of screw, the draft aft being given as 12 ft. 12 ins., instead of 13 ft. On page 47 of the text there was noted a minor typographical error in an equation near the bottom, w being written where π is meant. The typographical work in general, however, is excellent. The 25 plates are bound in with the text, but are so arranged that the portion of each plate which comes between the leaves when opened out is left blank, thus facilitating the examination of plates and text simultaneously. The lettering in the plates is in the characters of the German alphabet, while references in the text to the plates use Latin characters. This is a matter which is found annoying when following a figure by the description in the text.

In conclusion, it may be said that Volume I. of Herr Achenbach's work covers no new ground and contains little that is original, the portion of most value being a compilation or modification of the works of earlier workers in the field—to which, by the way, the author gives due credit. The special subject of the methods of graphic representation in connection with screw propellers is covered very fully and very well.

*Naval Constructor, U. S. N., U. S. Navy Yard, Washington, D. C.

REPORT ON SEWAGE PURIFICATION AT COLUMBUS, OHIO.—Made to the Chief Engineer of the Board of Public Service by George A. Johnson, Engineer in Charge of the Sewage Testing Station. November 10, 1905. Columbus, O.: Board of Public Service (Henry Maetzel, Chief Engineer). Cloth; 6 × 9¼ ins.; pp. 490; folding and other plates and many tables. Postage, 19 cts.

This valuable report on sewage purification experiments at Columbus was abstracted at such length in Engineering News for March 29 and April 5 that further notice seems unnecessary.

SCIENTIFIC ASPECT OF WATER PURIFICATION.—By Freeland Howe, Jr., Sanitary Chemist and Bacteriologist. Pittsburg, Pa.: Pittsburg Filter Manufacturing Co. Paper; 6 × 9 ins.; pp. 53.

Those who wish to go somewhat deeply into the physics and chemistry of water purification, without consulting original authorities, will find this pamphlet of service.

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Bristling with valuable data. CEMENT AND ENGINEERING NEWS, Nov. 1905.
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Pattern Making.

Reviewed by W. W. Bird.*

PRACTICAL PATTERN MAKING.—A Treatise for the Use of Pattern Makers, Foundrymen, Apprentices and Others. By Herbert Aughtie, A. M. I. Mech. E. Second Edition. Manchester, Eng.: The Scientific Publishing Co. Cloth; 5½ × 8¾ ins.; pp. 166; 237 figures in the text. 4s., net; American price, $1.60.

This is the second edition of a very good book on the subject of pattern-making. To those familiar with patterns and foundry usages the book will be of special value, as it is not padded with general principles and elementary work. The first chapter is all that is given up to preliminaries, the next six are on peculiarities of the trade, such as loose pieces, skeleton patterns and lifter plates.

Chapter VIII., on Loam Molding, is especially good. It is well known that the English foundryman excels in this branch; more space could well be allowed for this subject. The two examples given, however, are well illustrated and fully explained. The remaining chapters consider more elaborate patterns. The final chapter describes a band saw in detail. It would be better to devote this space to telling what can be done with a band saw. The author evidently does not consider that the modern molding machine is worthy of being considered in connection with pattern work; at least, he does not mention the subject.

For genuine information upon pattern construction, variety of examples and completely dimensioned illustrations, this book is worthy of a place in the front rank.

A PRACTICAL TREATISE ON THE STEAM ENGINE INDICATOR AND INDICATOR DIAGRAMS.—With Notes on Engine Performance, the Expansion of Steam, Behavior of Steam in Steam Engine Cylinders, and on Gas and Oil Engine Diagrams. By W. Worby Beaumont. Second Edition, Revised and Enlarged. New York: D. Van Nostrand Co. London, Eng.: "The Electrician" Printing & Publishing Co., Ltd. Cloth; 5½ × 8¾ ins.; pp. 261; 128 figures in the text. $2.50, net.

The principal part of Beaumont's "Steam Engine Indicator" is a series of chapters which explain the form of indicator-card given by various types of engine. These chapters contain many specimen diagrams and a fairly clear text accompaniment. Beginning with a diagram taken on an old atmospheric engine, presumably built by Smeaton, the scope of simple, compound and multiple-expansion engines is covered, including such special forms as compound engines of the tandem type with "idle" spaces acting as compensating cylinders. Gas engine diagrams are discussed in a further chapter. This latter chapter, however, exhibits well the principal deficiencies of the book. The delicate subject of gas engine indicating is represented in but a very elementary, non-thorough manner; in fact, one may read the chapter without realizing the distinguishing difficulties of the gas engine in respect to indicating. Throughout the book thoroughness and analytical instruction are sacrificed to an easy style of description. Thus no hint is given of what degree of accuracy may be obtained in an indicator diagram and how accurately the diagram may then be measured—a matter which vitally affects every engine test and every test report. The introductory chapters describing the indicator, and a very unsatisfactory chapter on drum-actuating arrangements and the attachment of the indicator, together about 60 pages, accomplish little more than to show one or two styles of the ordinary or "standard" indicator; in addition, a single continuous indicator and a clock-driven indicator are shown, and an optical indicator is mentioned. There is no evidence that integrating indicators have ever been made or that indicator springs need occasionally to be calibrated.

The avoidance of mathematics and the use of a very simple though often clumsy and tedious style make the book of service to many who would not appreciate a treatise on the indicator. For such, and as a descriptive text on cards, the book has value, but even here the failure to discuss the study of engine defects as revealed by indicator cards is a serious fault.

*Professor of Mechanical Engineering and Director of the Washburn Shops, Worcester Polytechnic Institute, Worcester, Mass.

EMINENT ENGINEERS.—Brief Biographies of Thirty-two of the Inventors and Engineers who did Most to Further Mechanical Progress. By Dwight Goddard, M. Am. Soc. M. E. New York: The Derry-Collard Co. Cloth; 5½ × 8 ins.; pp. 280; illustrated. $1.50.

In selecting the 32 subjects for these biographies, the honors were equally divided between American and European engineers. The American sketches are headed by Benjamin Franklin and John Fitch, and concluded by James B. Eads. Arkwright, Newcomen and Watt head the Europeans, and Bessemer and Sir William Siemens close the list. Some of the sketches have already been noted in these columns in their original form, they having first been issued, from 1903 on, as monthly bulletins by Wyman & Gordon, of Worcester, Mass., and Cleveland, O. Some of the sketches have since been enlarged and revised. In selecting the names, the object was to include men who had "accomplished something of importance in the development and application of power and machinery." The volume, as a whole, brings together, in convenient and readable form, brief biographies of men whose careers are of interest to every engineer.

UNDERGROUND WATER RESOURCES OF LONG ISLAND, NEW YORK.—By A. C. Veatch, C. S. Slichter, Isaiah Bowman, W. O. Crosby and R. E. Horton. Professional Paper No. 44, U. S. Geological Survey. Charles D. Walcott, Director. Washington, D. C.: Pub. Doc. Paper; 9 × 11½ ins.; pp. 394; 34 plates (three in pocket) and 71 text illustrations.

The underground water resources of Long Island have long been a subject for speculation, and later for careful study. Their importance to Brooklyn as sources of water supply have added greatly to their interest. In this large volume Mr. Veatch first outlines the geology of the island and describes its underground water conditions. The section of greatest interest to engineers is the one contributed by Professor Slichter, on "Measurements of Velocity of Underflow on Long Island." The arrangement of test wells and the electrical devices used for recording the underground flow during the tests are fully described and illustrated. Professor Slichter concludes that "large amounts of ground water can still be obtained along the south shore of the island, especially if deep wells of large diameter can be successfully bored." He considers it probable that the California, or "stovepipe," method of well sinking would be successful on Long Island (see Engineering News, Nov. 12, 1903). Mr. Veatch and Mr. Bowman present a compilation of well records, and Mr. Crosby contributes 16 pages on "Results of Sizing and Filtration Tests." The surface streams of Long Island are described by Mr. Horton and the results of gagings are given. Altogether the monograph is one of the most notable ones ever issued on underground waters.

MASSACHUSETTS HIGHWAY COMMISSION.—Thirteenth Annual Report. January, 1906. Boston, Mass.: Pub. Doc. (No 54). Cloth; 5½ × 9 ins.; pp. 99; many tables and folding map.

NEW JERSEY COMMISSIONER OF PUBLIC ROADS.—Report for the year ending Oct. 31, 1905. Trenton, N. J.: Pub. Doc. Cloth; 6 × 9 ins.; pp. 174; plates and large folding map.

These two reports follow the well-known lines of previous issues. Each describes in some detail the work of the year and gives many valuable figures of cost. The Massachusetts report contains more statistical matter than does that from New Jersey. An appendix to the Massachusetts volume is devoted to a report by the Forester of the Commission, Mr. Edward W. Breed, who has charge of the planting of shade trees on State highways. The New Jersey report contains "Standard State Aid Spesifications for Stone Roads," which cover the subject in considerable detail. It also contains brief papers on "Road Maintenance," by Robert A. Meeker; "Road Repairs," by James Owen, and "Dust and Its Prevention," by J. J. Albertson.

CONDITION AND COST OF COUNTRY ROADS IN OHIO.—Bulletin No. 6, Highway Department, State of Ohio. Sam Huston, Commissioner. Columbus, O.: Pub. Doc. Paper; 6½ × 9½ ins.; pp. 95.

There are here presented the results of an attempt to secure detailed information regarding the condition and cost of county and township roads in Ohio. Unfortunately, the respective authorities did not respond at all well to the detailed inquiries sent to them. The returns are so incomplete that no summaries for the whole State could be made. Such figures as were reported for the mileage of earth, gravel, macadam, unclassified unimproved roads, toll roads, and totals of the foregoing, are given by counties, following the detailed text for each county and town reporting. Aside from the facts already indicated, the various reports contain information on the organization of road work, scrapers and other equipment in use, taxes raised in the form of labor and of money for road improvement, and the character and cost of some of the roads.

ROADMASTERS AND MAINTENANCE OF WAY ASSOCIATION.—Proceedings for 1905. Beardstown, Ill.: C. E. Jones, Secretary. Cloth; 5¾ × 8¾ ins.; pp 147.

In addition to reports and discussions on ties, rail joints, hand cars, distributing and laying rails and ties, and lining and surfacing track, there are three papers, as follows: "Advances in Track Improvement," W. M. Camp; "Track for Modern Trains and Tonnage," A. Morrison, and "Switches and Frog and Switch Protection," E. E. R. Tratman, of the editorial staff of Engineering News.

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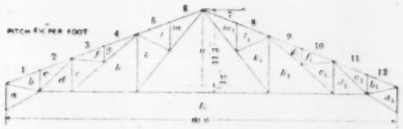

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Literary Magazines.

"The Pan-American Railway" is the subject of an interesting article by Mr. Chas. M. Pepper in the April "Scribner's." Mr. Pepper does not claim that the railway as a whole is likely to be built at any early day, or that when built its through traffic, carried in competition with ocean lines of transport, would be of any economic importance comparable with that of our transcontinental railways. What he does claim, and is undoubtedly correct in claiming, is that a large part of the proposed line is needed as a matter of local development by the several countries through which it will pass. At present more is being done in the Andes countries of South America in the way of railway construction than for many years past, and the work is reviewed by Mr. Pepper. The total length of railway required to be built to complete a continuous line connecting the present Mexican railway lines on the north with the Argentine lines on the south is nearly 5,000 miles, and a large part of this will be over some of the most difficult country that railways have ever covered. The complete realization of the dream of the Pan-American railway enthusiast, therefore, certainly lies very far in the future.

"The World's Work" for April is devoted to life insurance and its problems, many practical and helpful articles on life insurance, of interest to policyholders, being included. In "The Review of Reviews" this month the work of the Reclamation Service in the Colorado Delta is described by Mr. C. J. Blanchard, the Service's Statistician. "Volcanoes and Earthquakes in the Carribean Region," by Dr. Francis C. Nicholas, is another "Review of Reviews'" paper of particular interest just now when a volcano in another part of the globe is attracting world-wide attention. Still another engineering matter to which this magazine gives attention is the International control of Niagara to prevent destruction of the great cataract.

Publications Received.

DIE ABWASSERREINIGUNG.—Mit Rücksicht auf die Reinhaltung der Wasserläufe vom Hygienisch-technischen Standpunkt. From a paper read before the Deutschen Medizinalbeamtenvereins, September, 1905. By Prof. K. Thumm, Member of the Royal Testing Laboratory for Water Supply and Sewage Disposal. Berlin, Germany: Carl Heymann. Paper; 6 × 9¼ ins.; pp. 16.

AMERICAN MINING CONGRESS.—Proceedings of the Seventh Annual Session. Part II. Containing the Papers of 1904. Portland, Oregon, Aug. 22 to 27, inclusive. Denver, Colo.: The Congress (James F. Callbreath, Jr., Secy.). Paper; 6 × 9 ins.; pp. 232; illustrated.

THE AMERICAN MOSQUITO EXTERMINATION SOCIETY.—Year Book for 1904-1905. Containing the Proceedings of the Second Anti-Mosquito Convention, held in the City of New York, December 15 and 16, 1904. Edited by Henry Clay Weeks and Edward Hagaman Hall, Secretaries. New York: The Society (Office of Secretary, Bayside, L. I.). Paper; 5¾ × 9 ins.; pp. 116 + 12; illustrated.

BULLETINS, U. S. GEOLOGICAL SURVEY.—Charles D. Walcott, Director, Washington, D. C.; Pub. Doc. Paper; 5¾ × 9 ins.

No. 269: Corundum and Its Occurrence and Distribution in the United States. (A revised and enlarged edition of Bulletin No. 180.) By Joseph Hyde Pratt. Pp. 175; 18 plates and 26 text figures.

THE CITY CLUB OF NEW YORK.—Report 1904-5. New York: The Club (Lawrence Veiller, Secy., 55 West 44th St.) Paper; 6 × 9 ins.; pp. 143.

CONCRETE STEEL BRIDGES AND VIADUCTS.—(Written in Russian.) By G. Podolsny. Moscow, Russia: The Author. Paper; 7 × 10¼ ins.; pp. 476; 304 figures in the text and many tables.

DISTRIBUTIONS d'EAU.—Assainissemen des Villes. By A. Debauve, General Inspector of Bridges and Parks, and Ed. Imbeaux, Engineer of Bridges and Parks. Third edition, revised and greatly enlarged. In three volumes. Paris, France: H. Dunod & E. Pinat. Paper; 6½ × 9¾ ins.; pp. 732 + 579 + 608; many text figures and tables; 72 plates in separate volume, 9¾ × 12½ ins.

ELEMENTARY ELECTRICAL ENGINEERING. — In Theory and Practice. A Class Book for Junior and Senior Students and Working Electricians. By J. H. Alexander, M. B., A. I. E. E., Author of "Model Engine Construction." London, Eng.: Crosby Lockwood & Son. New York: D. Van Nostrand Co. Cloth; 5 × 7½ ins.; pp. 208; 181 figures in the text. $2, net.

AN ELEMENTARY TREATISE ON PHOTOTOPOGRAPHIC METHODS AND INSTRUMENTS.—Including a Concise Review of Executed Phototopographic Surveys and of Publications on this subject. By J. A. Fiemer, Topographical Engineer. New York: John Wiley & Sons. London, Eng.: Chapman & Hall, Ltd. Cloth; 5¼ × 9¼ ins.; pp. 438; 100 plates. $5.

HEAT AND LIGHT FROM MUNICIPAL AND OTHER WASTE.—By Joseph G. Branch, M. Am. Soc., M. E. Chief of the Department of Inspection Boilers and Elevators, Member of the Board of Examining Engineers for the City of St. Louis. St. Louis, Mo.: National Equipment Co. Cloth; 5½ × 8 ins.; pp. 305; 56 illustrations in the text. $3.

HILFSBUCH FUR DAMPFMASCHINEN-TECHNIKER.—Edited by Josef Hrabák, Professor in the School of Mines at Pribram. Fourth Edition. In three parts. Berlin, Germany: Julius Springer. Cloth; 7¾ × 11 ins.; pp. xix + 220 + 348 + 154; text figures and many tables. 20 marks. American price, $8.

IRRIGATION IN THE MADRAS PRESIDENCY.—Report for the year 1904-5. (A. H. Garrett, Chief Engineer for Irrigation.) Madras, British India: Pub. Doc. Boards; 8 × 13¼ ins.; pp. 128; folding map.

JAHRBUCH DER SCHIFFBAUTECHNISCHEN GESELLSCHAFT.—Seventh Volume. Berlin, Germany: Julius Springer. Cloth; 7½ × 10¾ ins.; pp. 715; illustrated. 40 marks; American price, $16.

THE MERCHANTS' ASSOCIATION OF NEW YORK.—Year Book, 1906. New York: The Association (S. C. Mead, Secy., New York Life Building). Paper; 6½ × 10 ins.; pp. 66.

METALLURGICAL CALCULATIONS.—By Joseph W. Richards, A. C., Ph. D., Professor of Metallurgy in Lehigh University, Author of "Aluminum, Its Metallurgy, etc." Part I. Introduction, Chemical and Thermal Principles, Problems in Combustion. New York: McGraw Publishing Co. Cloth; 6 × 9¼ ins.; pp. 208. $2, net.

MUNICIPAL OWNERSHIP IN GREAT BRITAIN.—By Frederic C. Howe, Ph. D. (In Bulletin 62, U. S. Bureau of Labor, January, 1906.) Washington, D. C.: Pub. Doc. Paper; 5¾ × 9 ins.; pp. 1—123; many tables.

ON THE EXTERMINATION OF THE MOSQUITO.—By A. H. Doty, M. D., Health Officer of the Port of New York. (Extracted from the American Journal of the Medical Sciences, February, 1906. Paper; 6 × 9 ins.; pp. 10.

PANAMA TO PATAGONIA.—The Isthmian Canal and the West Coast Countries of South America. By Charles M. Pepper, Author of "To-morrow in Cuba." Chicago, Ill.: A. C. McClurg & Co. Cloth; 5¾ × 9 ins.; pp. 398; illustrated.

PRESENT STATUS OF WATER ANALYSIS IN CONNECTION WITH THE INVESTIGATION OF TYPHOID EPIDEMICS.—By Ernest C. Levy, M. D., Richmond, Va., Director of Laboratory of City Water Department. (Read before 36th Annual Session of the Medical Society of Virginia at Norfolk, Oct. 24-27, 1905.) Paper; 5¼ × 8 ins.; pp. 11.

REDUCTION OF RATES FOR ELECTRIC LIGHT.—A Report Submitted to the Chicago City Council by Bion J. Arnold, Consulting Engineer and William Carroll, City Electrician. Paper; 6 × 9 ins.; pp. 12.

REPORT OF THE CHIEF OF THE MINING BUREAU.—To the Honorable Secretary of the Interior. By H. D. McCaskey, Chief of the Mining Bureau. Being for the year ended August 31, 1905. Manila, P. I.: Pub. Doc. Paper; 5¾ × 9 ins.; pp. 66; three folding maps and 13 plates.

REPORT ON THE OPERATIONS OF THE COAL-TESTING PLANT OF THE UNITED STATES GEOLOGICAL SURVEY AT THE LOUISIANA PURCHASE EXPOSITION, ST. LOUIS, MO., 1904.—Edward W. Parker, Joseph A. Holmes, Marius R. Campbell, Committee in Charge. Professional Paper, No. 48, U. S. Geological Survey. Charles D. Walcott, Director. Washington, D. C.: Pub. Doc. Paper; 9 × 11½ ins.

Part I. Field Work, Classification of Coals, Chemical Work. Pp. 1 to 300; three plates (one in pocket) and 10 text figures.

Part II. Boiler Tests. Pp. 301 to 979; four plates and 93 text figures.

Part III. Producer-gas, Coking, Briquetting and Washing Tests. Pp. 980 to 1492; six plates and 32 text figures.

SANITARY PAPERS.—Reprinted from The Journal of Infectious Diseases, Supplement No. 2, February, 1906. Paper; 6¾ × 9½ ins. (for the first two address Mr. Gage, at the Lawrence Experiment Station, Lawrence, Mass.; for the others, Mr. Kimberly, Board of Public Service, Columbus, O.)

The Collection and Preservation of Samples of Sewage for Analysis. By Stephen DeM. Gage and George O. Adams. Pp. 139 to 148.

On the Bactericidal Action of Copper. By H. W. Clark and Stephen DeM. Gage. Pp. 175 to 204.

Relative Applicability of Current Methods for the Determination of Putrescibility in Sewage Effluents. By George A. Johnson, William R. Copeland and A. Elliott Kimberly. Pp. 80 to 96.

A Comparative Review of Current Methods for the Determination of Organic Matter in Sewage. By George A. Johnson and A. Elliott Kimberly. Pp. 97 to 108.

The Practical Advantages of the Gooch Crucible in the Determination of the Total and Volatile Suspended Matter in Sewage. By A. Elliott Kimberly and Harry B. Hommon. Pp. 123 to 135.

A Method for the Direct Determination of Organic Nitrogen by the Kjeldahl Process. By A. Elliott Kimberly and M. G. Roberts. Pp. 109 to 122.

UNITED STATES STATUTES CONCERNING THE REGISTRATION OF TRADE-MARKS.—With the Rules of the Patent Office Relating Thereto. Revised December 1, 1905. (Frederick I. Allen, Commissioner of Patents.) Washington, D. C.: Pub. Doc. Paper; 5¾ × 9 ins.; pp. 54; one folding plate.

WATER-SUPPLY AND IRRIGATION PAPERS, U. S. GEOLOGICAL SURVEY.—Charles D. Walcott, Director. Washington, D. C.: Pub. Doc. Paper; 6 × 9 ins.

No. 154: The Geology and Water Resources of the Eastern Portion of the Panhandle of Texas. By Charles N. Gould. Pp. 64; 15 plates and 4 text figures.

YARDS AND TERMINALS AND THEIR OPERATION.—By J. A. Droege, Division Superintendent, New York, New Haven & Hartford R. R. New York: The Railroad Gazette. Cloth; 5¾ × 9 ins.; pp. 285; 81 figures, mostly in the text. $2.50.

BOOKS WANTED

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and other engineering societies; also complete or long runs of any standard engineering periodicals.

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THE PURIFICATION OF WATER AT MARIETTA, O.—Official Report. (Submitted by C. Arthur Brown, Sanitary Engineer to the Board of Public Service, Marietta.) Chicago and New York: American Steel & Wire Co. Paper; 5½ × 7¾ ins.; pp. 60; folding and other plates.

Detailed text and tables describe tests of mechanical filters in which copper-iron sulphate was used as the coagulant, in connection with lime. The tests extended from May 16 to 30, 1905. It should be noted, for the benefit of the uninformed, that the copper-iron sulphate is made by the company named above as publishers. Appended to the report is a table showing the quantity of metallic copper found in a great variety of natural objects, including various food stuffs, blood, milk and different organs of animals.

NEW JERSEY SANITARY ASSOCIATION.—Proceedings for 1905. (James A. Exton, M. D., Arlington, Secy.) Paper; 6 × 9 ins.; pp. 75.

The chief paper herein of interest to engineers is "Sewage Disposal on the Atlantic Coast," by Mr. George W. Fuller. The paper was reprinted in full in Engineering News of Jan. 25, 1906. Among the other subjects discussed are the construction and management of creameries, disinfection, and laboratory training for health officers.

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